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TO THE

BIENNIAL REPORT OF THE BOARD OF REGENTS.

SACRAMENTO.
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REPORT OF THE PROFESSOR OF AGRICULTURE

TO THE

PRESIDENT OF THE UNIVERSITY.

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TABLE OF CONTENTS.

	Page.
GENERAL REPORT OF PROFESSOR E. W. HILGARD	13
Instruction	13
Small attendance preferable to an inefficient course	13
Attendance and instruction during 1885–6	13
Resignation of Mr. C. H. Dwinelle	13
Appointment of Mr. E. J. Wickson	13
Botany not taught	13
Attendance and instruction during 1886–7	14
Resignation of Mr. W. G. Klee	14
Vacancy not filled	14
Provision for performance of duties	14
Reappointment of Mr. E. J. Wickson	14
Election of Mr. E. L. Greene as Lecturer on Botany	14
Attendance on the several classes	14
Special course on vinification and chemistry of wines	14
Future requirements of instruction	14
Extension of the department of botany	14
Need of a specialist for entomology	14
Insect pests and a State Entomologist	15
Short course in agriculture, to have a definite status	15
Laboratory room and instruction for agricultural students	15
Present accommodations of the department, and need of increase of same	15
Possible arrangements in the South Hall	15
Alternative of removal to a new building	15
Experiment Station Work	16
Forms a large proportion of the whole work	16
Exceptional need in California	16
Extended correspondence involved	17
Too much detailed work for present force	17
Need of a division of duties in discussion of results	17
The Hatch experiment station bill may afford the needed relief	17
Another analyst needed in the general agricultural laboratory	17
Another assistant needed during vintage in the viticultural laboratory	17
Rules governing the work	17
Matters of public interest only admitted, and only gratuitous work done	17
Difficulty of determining exact limits	18
Practice regarding waters and soils	18
Matters of private interest referred to private workers	19
Field experiments and garden of economic plants	19
Need of new greenhouses	19
Defective heating apparatus	19
Accumulation of stock on propagating grounds	20
How to dispose of same	20
Underdraining of agricultural grounds needed	20

PAGE.

APPENDIX I—RECORD AND DISCUSSIONS OF WORK IN THE GENERAL AGRICULTURAL LABORATORY—EXAMINATIONS AND ANALYSES OF SOILS, WATERS, AND MISCELLANEOUS SUBSTANCES 22

I. ANALYSES OF SOILS 22

A. *Great Valley* 22

Soils from the "bedrock lands" 22

The bedrock lands of Sacramento County—Bulletin No. 44 22

General adaptation of valley border lands to fruit culture 22

Soils from Florin; Wm. A. Lawson 23

Soils from Mayhew Station; D. Lubin 23

Merits and defects 23

Analyses of soil, subsoil, and "bedrock" 24

The "bedrock" as a source of plant food 24

Blasting with Judson or giant powder 25

Probable results 25

Soils from the Tulare Lake border 25

Soils from George E. Raymond's land 25

Same from E. R. Thomason's land 26

Analyses and discussion 26

Importance of reclamation of Tulare Lake lands 27

Examinations of alkali soils 27

Alkali soil from near Courtland; W. F. Gammon 27

Alkali soil from East Park, Sacramento; James Rutter 28

Same from south border of Tulare Lake; Mrs. Moore 28

Soil from Easton, Fresno County; L. Hanson 29

B. *Sierra foothills* 29

Subsoil from Colfax, Placer County; M. Lobner 29

Soils from near Grass Valley, Nevada County; H. H. Hanssen 30

Unusual character of these soils 31

C. *Southern region* 32

Soils from Riverside, San Bernardino County; George L. Waring 33

Gravelly adobe from Orange; C. F. Stamps 33

D. *Coast Range south of the Bay* 34

Soil from Silk Culture Station, Piedmont, Alameda County 35

Marsh soils from near Seminary Park; Byron Jackson 35

Pacheco and Ignacio Valley soils 36

Soil from Concord, Pacheco Valley; S. Farjeon 36

Soil from Bancroft ranch, Ignacio Valley; A. L. Bancroft 38

Mountain View soils 39

Dark loam soil; J. S. Bunnell 39

Loam soil; J. A. Sladky 40

Cupertino Vineyard soils 41

Soil, subsoil, and under-subsoil from University Vineyard plot, John T. Doyle's ranch 41

Under-subsoil fron Montecito, Santa Barbara County; H. C. Ford 43

Gray loam soil; Mrs. Truesdell, Ventura County 43

E. *Coast Range, north of the bay* 44

Marsh soil, Sonoma Landing; A. J. Henderson 44

Soils and subsoils, Edgehill Vineyard, Napa County; Wm. Sheffler 45

Remarkable variety of soils 45

Upland soil from Conn Valley; A. W. Perry 47

PAGE.

Vineyard soils from Glen Ellen, Sonoma County; J. H. Drummond 47
Subsoil from near Cloverdale, Sonoma County; J. H. Whitman 49
Upland soils, Elder Creek, Tehama County; Huntington, Hopkins & Co.... 50
Table 1—Analyses of soils and subsoils 52
2. ANALYSES OF WATERS 52
A. *Artesian waters* 52
From P. C. Phelps, Upper Lake, Lake County 52
From Stockton Asylum for the Insane; W. M. Fitzhugh 52
From Dr. John Hastings' place, near Fresno 53
Boiler crust, B. Marks, Fresno 53
From near Lemoore, Tulare County; E. Jacob 54
Same; Daniel Rhoads 54
From J. H. Hoskins' well, Kern County 54
From Section 33, Township 25, Range 23, Kern County; Geo. A. Raymond.. 55
From West Side Water Company, Los Angeles 55
B. *Well waters* 56
From General Bidwell, Chico 56
From Mrs. E. D. Murray, Auburn 56
From C. W. Reed, Sacramento 57
From W. S. Leber, Santa Rosa 57
From Napa Asylum; Dr. Dozier 58
From Amos Bailey, Pacheco 58
From the Bancroft ranch, Ignacio Valley 58
From G. W. Wilson, San José 59
From C. Fowler, San Miguel 59
From near Eisen Vineyard, Fresno; J. W. Pew 59
From near San Buenaventura 60
From Hueneme, Ventura County; E. O. Gerberding 60
From Highland Park Tract, Los Angeles; William Inglis 61
From well of L. F. Gay, Los Angeles 61
C. *Spring waters* 62
From hot spring, Agua Rica, Sonoma Valley; Captain H. E. Boyes 62
From Walter Soda Springs, Napa County 62
From Corralitos, Santa Cruz County; L. A. Raleigh 63
Hot spring waters from Pico Blanco, Monterey County; J. Kelleher 63
From Mrs. Turner's place, thirty miles north of Visalia, Tulare County; Horace Whitaker 64
From spring on Kern River, east of Sumner Station; John Parker 64
From Arrowhead Hot Springs, San Bernardino; Darby & Lyman 64
Drainage water from underdrains at the Stockton Asylum for the Insane.. 65
3. ANALYSES OF ROCKS, MARLS, AND FERTILIZERS 66
Calcareous sandstone, from near San Mateo 66
Marlstones from the Coast Range off Woodland, Yolo County; N. Wyckoff. 66
Limestone from near San Miguel, Santa Barbara County; R. R. Kirkpatrick. 66
Marlstone from near Orange, Los Angeles County; C. F. Stamps 67
Gypsum, from same 67
Eruptive "bedrock;" C. D. Brooks, Diamond Springs 67
Calcareous tufa, from near Guerneville, Sonoma County; G. W. Merck 67
Calcareous tufa, from Santa Cruz Range; E. Parker, San Francisco 67
Tartar waste, from refining of argols; A. Haas 67
Commercial alkalies 68
Philadelphia solid lye 68

PAGE.
American concentrated lye 68
Ninety-eight per cent caustic soda 68
Refined pearlash 68
Commercial potash 68
Canadian crude potashes 68
Eureka lye 68
4. EXAMINATIONS OF VEGETABLE PRODUCTS, FRUITS, ETC. 69
Syrups from the Alvarado sugar factory, before and after passing through the osmogenes 69
Table of analyses 70
Proportions of salts to sugars 70
Summary of changes 71
Fertilizing ingredients of defecation slum 71
Examinations of oranges and lemons 71
Errors regarding the sugars in oranges 72
Glucose in the fruit 72
Table showing composition of Riverside Navel, Mediterranean Sweet, and Riverside Seedling 73
Analyses of oranges and lemons from the Riverside Citrus Fair, 1885 73
Peculiar merits of the Navel 73
Analyses of North California citrus fruits 75
Inferior condition of fruit when analyzed 75
Table No. 2—Analyses of North California citrus fruits 76
General conclusions 77
Utilization of unsalable limes and lemons, preparation of commercial citrate of lime, and essential oils 77
Mr. F. Gutzkow's process 78
Shipments of citrus products from Messina 78
Tests for arsenic on apples sprayed with arsenical solution 79
Preparation of sulphide whale-oil soap 79
APPENDIX II—REPORT ON GRASSES, FORAGE PLANTS, AND CEREALS, BY E. J. WICKSON 81
GRASSES AND FORAGE PLANTS 81
Note on the conditions and needs of California pastures 81
Work of the College of Agriculture toward the improvement of pastures 82
SORGHUM HALEPENSE 82
Discussion of its growth in this State 82
Reports of experimenters in all parts of the State 83
SHRADER'S BROME GRASS (*Bromus unioloides*) 85
Introduction in United States 85
Distribution by the Patent Office about 1856 86
How it was sent from California to Australia 86
Proofs of its value in Australia 87
Its introduction into Europe from Australia 87
Reintroduction into the United States 87
Reports of its value in the Southern States 87
Botanical classification of the plant 87
Analyses showing its nutritive quality 88
How the seed came to California and to the University 89
Reports of growers in different parts of the State 89
HUNGARIAN BROME GRASS (*Bromus inermis*) 90
Its characteristic qualities 90

PAGE.

Reports of experimenters in California 91
MANY-FLOWERED MILLET GRASS (*Milium multiflorum*) 91
Character and value in California 92
SNAIL CLOVER (*Medicago turbinata*) 92
AUSTRALIAN SALT BUSHES (*Atriplex* sp.) 93
Reports from California growers 93
SORGHUMS AS FORAGE PLANTS 94
Trials of varieties on the University grounds 94
Table of yields at different cuttings 94
Second growths and their yield 95
Varieties grown:
Honduras 95
Stewart's Hybrid 95
Rural Branching 95
Chinese Imphee 95
Early Amber 95
Early Orange 95
Kaffir Corn 95
Pearl Millet (*Penicillaria spicata*) 95
TAGASASTE 96
FLORA OF THE MOUNTAIN PASTURES OF CALIFORNIA 96
LIST OF GRASSES AND CLOVERS IN THE EXPERIMENTAL PLOTS 97
University garden of economic plants 97
REPORTS OF RESULTS OF DISTRIBUTION OF CEREALS 98
Sketch of the University collection of cereals 98
Tests of varieties at the University 98
Characteristics learned by such tests and by the experience of growers in all parts of the State with the following varieties, viz.:
Six-rowed barley 99
Bald or Nepaul barley 99
Frick's drought-proof barley 100
Blue barley 101
Comparative yields of varieties in San Joaquin County 101
Brief notes on other varieties 102
Wheats: Pringle's Defiance 102
Various other wheats 103
Grain tests on Rancho Chico by Gen. Bidwell 103
Table showing results of the same 105
Ryes: St. John's Day 106
Oats: Brief notes on varieties 106
Chinese buckwheat 106
APPENDIX III—REPORT ON ECONOMIC TREES AND PLANTS AND TESTS OF FRUIT-VARIETIES IN THE UNIVERSITY ORCHARD BY W. G. KLEE 108
The carob (*Ceratonia siliqua*) 108
The olive 109
The pear-shaped guava (*Psidium pomiferum or P. pyriferum*) 115
The strawberry guava (*Psidium Cattleyanum*) 116
The melon tree (*Carica papaya*) 116
The hovenia dulcis of Japan 116
The li-chi (*Nephelium*) 116
The pistachio nut (*Pistachia vera*) 117

Page.

The chio or cyprian turpentine tree (*Pistachia terebinthus*) ---- 117
The camphor tree (*Camphora officinalis*) ---- 118
The cinamon tree (*Cinnamomum glaucum*) ---- 118
The catalpa (*Catalpa speciosa*) ---- 119
The black wattle (*Acacia decurrens*) ---- 119
The jarrah or yarra tree (*Eucalyptus marginata*) ---- 120
The Italian chestnut (*Castanea vesca*) ---- 120
The oriental sycamore (*Platanus orientalis*) ---- 121
The cork oak (*Quercus suber*) ---- 121
The English oak (*Quercus robur*) ---- 121
Various Chilean trees:
Boldoa fragrans ---- 122
Persea lingue ---- 122
Espino, Acacia, or *Mimosa cavenii* ---- 122
Bellota Miersii ---- 122
Mytenus Chilensis ---- 122
Psoralea glandulosa ---- 122
Textile Plants ---- 122
Esparto grass (*Stipa tenacissima*) ---- 122
Esparto grass (*Lygeum sparteum*) ---- 123
North African basket grass (*Festuca altissima*) ---- 123
New Zealand flax (*Phormium tenax*) ---- 123
Ramie (*Boehmeria tenacissima*) ---- 124
Varieties of common flax (*Linum usitatissimum*) ---- 125
Russian blue flowering ---- 125
Royal white flowering ---- 125
White flowering from France ---- 125
Yellow seeded ---- 125
Medicinal Trees and Herbs ---- 126
Cinchona species ---- 126
Rhubarb (*Rheum officinale*) ---- 126
Russian rhubarb (*Rheum palmatum*) ---- 126
Rhubarb from Berlin (*Rheum undulatum*) ---- 126
German chamomile (*Matricaria Chamomilla*) ---- 126
Roman chamomile (*Anthemis nobilis*) ---- 126
Jalap (*Ipomea purga*) ---- 127
Bamboos ---- 127
Chinese (sp.?), from Gen. Kirkham ---- 127
Ringal or nigala (*Arundinaria falcata*) ---- 127
Himalayan (*Thamnocalamus spathiflorus*) ---- 127
Miscellaneous Plants ---- 128
Quinoa (*Chenopodium quinoa*) ---- 128
Tea plants (*Thea bohea*) ---- 128
Lemon grass of India (*Cymbopogon schœnanthus*) ---- 129
Ground cherry (*Physalis edulis*) ---- 129
Chinese yam (*Dioscorea batatas*) ---- 129
Japanese starch plant (*Pueraria Sieboldtii*) ---- 130
Caper bush (*Capparis spinosa*) ---- 130
Insect powder plants (*Pyrethrum cinerifolium* and *P. roseum*) ---- 130
Report on the Standard Orchard and Tests of Fruit Varieties ---- 130
Description of conditions affecting the growth of fruit varieties in Berkeley. 130
Kinds of fruit best suited to such conditions ---- 131

PAGE.

NOTES ON THE APRICOT 131
Varieties which do well:
Blenheim or Shipley 131
Hemskirk 131
Beauge 132
Orange or Royal 132
Long Red 132
Sardinian 132
Varieties which bear fine fruit but small quantity:
Large Alberge De Montgamut 132
St. Ambroise 132
Moorpark 132
Varieties which have not had fair trial, but promise well:
Kaisha 132
Canino Grosso 132
De Coulargе 132
Varieties found unsuitable after ten years' trial:
Early Golden, Breda, Red Masculine, Turkey, Malcolm Breda 132
TREATMENT OF THE TREES FOR INSECTS AND FUNGI 133
OBSERVATIONS ON THE CHARACTERISTICS OF PEARS AND APPLES 133
Table 3—Growth, ripening, and yield of Summer apples 134
Table 4—Growth, ripening, and yield of Fall apples 135
Table 5—Growth, ripening, and yield of Fall and Winter apples 136
Table 6—Growth, ripening, and yield of Summer and Fall pears 137
Table 7—Growth, ripening, and yield of Fall pears 138
Table 8—Growth, ripening, and yield of Winter pears 139
APPENDIX IV—REPORT ON ECONOMIC ENTOMOLOGY AND INSECTICIDES, BY E. J. WICKSON 140
Note on instruction 140
Need of a bureau of information, such as would be provided by a department of economic entomology at the University 140
EXPERIMENTS WITH THE HESSIAN FLY (*Cecidomyia destructor*) 141
Appearance of the insect on the University grain plots 141
Experiment of the Summer of 1886 141
Tables 9, 10, and 11—Showing effects of the attack of fly on different varieties of wheat, barley, and rye 142–4
Description of resistant wheats 144
Experiment showing the yields of these varieties 144
Resistance of varieties at the East and in California, compared 145
Experience of Mr. F. H. Burke, in San Mateo County 146
The grain aphis and joint worm mistaken for the Hessian fly 147
Popular method of distinguishing between them 147
Grain aphis on Egyptian corn 147
THE WOOLLY APHIS AND ITS REPRESSION. (Bulletin No. 55) 148
Occurrence of the insect in various parts of the world 148
Various remedies applied 148
Effects of treatment with gas-lime 148
Destruction of woolly aphis by ladybirds 149
Stocks resisting the aphis 149
THE PLUM APHIS AND ITS FOES 149
Experience of Mr. Johnson in Tehama County 150
Record of observations in the University plum orchard, in June, 1886 150

	Page.
The victory by the beneficial insects	151
The Chilocorus as a Destroyer of Scale Insects	151
Report by Mr. Haigh of Washington Territory	151
Pests on the Gooseberries in Ukiah	152
Description of the work of the insect by Mr. Wagenseller	152
Another Gooseberry Pest in Oregon	152
Report by Dr. F. S. Matteson, of Aumsville	152
Cicada eggs in apple twigs	152
Scale Insects and their Repression	153
Chemical analyses of commercial alkalies:	
Philadelphia solid lye	153
American concentrated lye	153
Double concentrated caustic soda, Greenbank Alkali Company	153
Refined pearlashes, same manufacturers	153
Commercial potash	153
Canadian crude potashes	153
Eureka lye	153
Practical suggestions as to making alkaline solutions, and application of them	154
A formula tested and commended	154
Whale-oil soap insecticide washes, Bulletin No. 56	155
Explanation of conflicting experiences in the use of whale-oil soaps	155
How good and poor soaps are made	156
A formula recommended to manufacturers	156
An Enemy of the Oaks (*Phryganidea Californica*)	156
APPENDIX V—REPORT ON THE DISTRIBUTION OF SEEDS AND PLANTS AND DONATIONS RECEIVED, BY E. J. WICKSON	157
Advantages of securing results of local experience in all parts of the State	157
Circular requesting reports from those who received seeds and plants for trial	157
Seed distribution of 1885–6, Bulletin No. 47	158
Plant and scion distribution, 1885–6, Bulletin No. 50	160
Summary showing geographical extent of the distribution and number of seed-packages and plants sent out, 1884–5	162
Statement of moneys received and expended	162
Summary of distribution of 1885–6	163
Statement of moneys received and expended	163
University Exhibits Made at the Leading Industrial Fairs in 1886	164
Report of the exhibit at the State Fair	164
Report of the exhibit made at the Mechanics' Institute Fair of 1886	165
Donations of Seeds and Plants to the University during 1885 and 1886	166

REPORT OF PROFESSOR E. W. HILGARD.

President E. S. Holden:

Dear Sir: I herewith respectfully submit a report of the operations of the department under my charge, for the years 1885 and 1886; with seven appendices containing the record and discussion of the experiment station work.

INSTRUCTION.

In regard to instruction, I cannot do better than repeat *verbatim* what I said on this subject in the report for 1884:

> I regret to say that the hopes I have entertained of a rapid increase of students in the College of Agriculture have not been realized. Since it has become apparent that the agricultural course has ceased to be a safe harbor for the indifferent student, and an easy road to graduation, its numbers have perhaps even fallen off; but there has been a corresponding increase of earnestness among those who do attend, that will certainly serve the objects for which the college was established better than the easy-going system which, in times past, led to its being considered the "Botany Bay" of the University. As matters now stand, those who really desire to pursue agricultural studies can do so without difficulty, by coming into the classes of either partial or special students, if they do not desire to graduate. And if under this arrangement the college should not have a graduate more than once in two years, it would still be fulfilling its functions better than by graduating students who have no serious thought of study, or of pursuing agriculture as a profession.

During the session of 1885–6 the agricultural course shared in the general depression of attendance upon the non-literary courses of the University. For want of attendance the lectures on general agricultural chemistry were not given by me; but during the second term a special course on vinification and the chemistry of wines was given to two special students, the lectures also being attended optionally by several students from other courses.

At the end of the session of 1884–5, Mr. C. H. Dwinelle, who for seven years past has held the lecturership of Practical Agriculture, declined renomination to the same position for the succeeding session, on account of an intended absence in Europe. The position was therefore tendered to Mr. E. J. Wickson, who for some time past had annually delivered twelve lectures on dairying as a special course, of great interest to those attending it. Mr. Wickson was elected to, and accepted, the lecturership on Practical Agriculture for the session of 1885–6, and during that session gave the usual courses in agriculture, horticulture, and economic entomology, to a small but attentive class.

No one having been elected to fill the position of Lecturer on Botany, that subject was not taught in the University during the session of 1885–6, although quite a number of applications made for instruction therein showed that a class of respectable numbers could have been formed; it being a subject needed by teachers in the schools of the State.

In arranging for the instruction to be given during the succeeding session of 1886–7, it became necessary to provide in some way for the vacancy created by the resignation of Mr. W. G. Klee, for eight years

head gardener of the agricultural experimental grounds, who in April, 1886, was elected to the position of Fruit Pest Inspector of the State, by the State Board of Horticulture. It was deemed best not to attempt to fill his position in the same sense as heretofore, it being difficult to find an incumbent of experience and qualifications similar to those of Mr. Klee. The gap was therefore covered by advancing the functions of the foreman, Mr. K. McLennan, to cover one portion of Mr. Klee's duties, while those of Mr. Wickson, reappointed as Lecturer on Practical Agriculture and Assistant Superintendent of the experimental grounds, were extended over the other. At the same time, the appointment of Mr. E. L. Greene as Lecturer on Botany provided most acceptably for the filling of a gap that had long formed a source of inconvenience and complaint.

The session of 1886–7 opened more auspiciously for the agricultural course than the preceding one. Three students presented themselves for the lecture course on agricultural chemistry, and the same number for the special course on vinification and the chemistry of wines, which had been announced on the program of the session. These students have shown themselves to be of the right kind, having in view the practice of agriculture and viticulture and therefore giving special and not merely perfunctory attention to the subjects before them. A few such will be of more importance to the college and the State than many times that number who would afterwards go into other callings; and I trust that this year's experience is a symptom of a healthy, even if not rapid, increase of attendance upon the agricultural instruction.

The courses of practical agriculture and economic entomology, were also applied for by four students, and have been steadily attended by them under the instruction of Mr. Wickson.

The class in botany, under the instruction of Mr. Greene, has from the beginning of the session numbered twenty-one, showing clearly the demand for instruction in that science, which I hope will never hereafter be allowed to be discontinued.

Future Requirements of Instruction. It is difficult to consider the needs of the department as regards instruction apart from the experiment station work, except as to *botany*, for which provision can and should be made independently, just as well as for geology or mineralogy. A well-conducted course of botany will always be largely attended, irrespective of the course in agriculture, and special arrangements for a botanical collection room or museum, with work rooms for botanical laboratory work, should form part of any plan for enlargement, in the near future. The agricultural lecture room is now crowded and cramped for room on account of the botanical collections which it must accommodate, and there is no room for the properly agricultural museum specimens, or for convenient work that properly belongs to the department of agriculture. The scope of botany is ample to form a department by itself, and a full professorship, with at least as much propriety as several others now enjoying that distinction.

I have in former reports urged the claims of *entomology* to such special attention as can only be given it by a specialist. Its importance in connection with the subject of insect pests is growing so rapidly, that before long some definite provision must be made for it by the State, in defense of several of her most important agricultural industries. A "State Entomologist," with headquarters at the University, part of whose duties should be to give instruction in entomology in the Course of Agriculture, while giving the greater portion of his time to the study of insect pests and the means for their repression, would probably be the best solution of the question. California has exceptionally large interests at stake in this connec-

tion, not only because of the vulnerability of the fruit industry to insect depredations, but particularly because from her tolerant climate and her direct maritime intercourse with all the world, the State is exceptionally exposed to the introduction of the dangerous insect pests of the whole globe. That in this matter prevention is, as usual, far easier than cure, California agriculturists have already learned to their sorrow. A State Board of Horticulture and its executive officer are perpetually working in the dark, for want of the fundamental condition of knowing what it is they are dealing with. When an officer of the State is heard, in the nineteenth century, gravely propounding the doctrine that certain insect pests originate by spontaneous generation in the moisture of the low grounds, and would disappear before better drainage, it seems high time that the proverbial "schoolmaster" should come around to clear off the mists of past centuries from his ideas. For a number of years the lectures on practical agriculture have given an elementary course of entomology to the classes in agriculture, with special reference to the repression of the better known insect pests. But this is a specialty requiring the full time and attention of a specialist, and the State could better afford to do without many other expenditures now made, than to neglect longer the provision for a State Entomologist.

In respect to the agricultural course in general, it has long been apparent that a shorter course of study than that leading to a degree should be definitely organized at the University. As a matter of fact such a course has long been actually in existence, and has had in it the best class of students, who came for professional study and cared little about any academic honors in the premises. But such students are on record only as "partial" or "special" course men, or even "visitors," although pursuing a perfectly definite plan of study. I earnestly recommend that a "two-years' course" for such students be made a recognized status in the institution, and that students desiring to take it be admitted with only such preliminary examinations as are necessary to show that they can pursue the studies of the course with profit. As the details of this plan are now under consideration by a committee of the Faculty, I omit any more detailed discussion in this place; but I am fully persuaded that the establishment and definite recognition of such a course will lead to a more frequent use of the opportunities afforded by the department, and the University at large, by the industrial class, for whose benefit the Morrill donation was mainly intended.

Another point requiring mention in this place is the need of *laboratory room* for students who desire to do special work on agricultural subjects, as is frequently the case. Such students are now obliged to work in the general chemical laboratory, and for instructions and direction in their work have to go back and forth between the two departments, with more or less unsatisfactory results. The agricultural laboratory, as it now stands, has room only for two working chemists, and this room should, in justice to the regular experiment station work, be occupied by two regular assistants where at present only one is employed. In the viticultural building provision has been made for a students' laboratory; and a similar provision is needed for students in general agriculture.

Present Accommodations—More Room Needed. At present the agricultural department occupies three rooms in the brick building known as South Hall. One is a basement room, occupied as an office, work room, lecture room and library. It is so situated that after an experience of several years, I have had to decline occupying it for any length of time, on the score of its unsanitary condition, which it is difficult to remedy. On the

first floor, the large room formerly occupied by the library now forms the lecture room and museum of agriculture and botany. Its crowded condition has already been alluded to. Adjoining it, in a room sixteen by twenty, is the general agricultural laboratory, which, as before stated, has room at most for two workers, but is now as a rule occupied by the assistant, Mr. Morse, alone.

In the original plan of the South Hall, the rooms intended for the agricultural department included, with those at present occupied, the two rooms now used as the Secretary's offices. If these could be vacated it would give some relief; but if the department of botany be taken into due consideration, even that would be inadequate in the course of a few years. For a proper development of the two departments little short of the entire first floor would form a permanently adequate provision.

As it is manifestly necessary to move the general chemical laboratory out of its present unsuitable apartments into a separate new building, the needful room for the agricultural and botanical departments could be thus vacated. As, however, a chemical laboratory, with its unavoidable odors and acid fumes, is an indispensable adjunct to the agricultural department, it is a question whether, on the same principle, it had not better be included in the move of the general chemical laboratory into new quarters, where it would not interfere with, or be interfered with by, the needs and requirements of other departments. The plans for a separate building that would accommodate both the agricultural department and, for the time being, that of botany, have already been submitted to you.

There is another possible arrangement which deserves serious consideration, as it would consolidate into one building all instruction and experimental work of the Agricultural Department. It is to locate the new building contiguous to the present viticultural laboratory, making the latter a part of it in such manner as may seem best, and thus doing away with the inconvenience and loss of time resulting from the scattering of the work among different buildings. It should not be forgotten that the necessity of passing from one building to another situated at a distance, imposes upon the members of the department a permanent tax, which to some extent detracts from their opportunities for close supervision of the work.

EXPERIMENT STATION WORK.

The experiment station work continues to form a very large proportion of the work of the department, as will be apparent from the record and discussions given in the Appendices to this report. In fact, the increase of public interest in this direction exceeds considerably that of our working capacity, and as a consequence the regular plan of operations, being substantially that of an agricultural survey of the State, is almost submerged in the piece-work constantly called for and representing an undoubted real want, which under the peculiar conditions of this State is probably very much greater than anywhere else in the United States. People see themselves face to face daily with problems for which they find no precedent either in their former homes, or even in books accessible to them, and are thus thrown upon a wide field of conjecture as to the proper mode of investing their money and labor. The fact that agricultural science embraces within its range almost every branch of human knowledge, not unnaturally suggests an application for information to the College of Agriculture; and this leads to an extensive correspondence, perhaps unparalleled in the variety of subjects upon which information is asked for, and therefore often involving not only elaborate investigation in the

laboratory, but the looking up of extended references on recondite subjects, some of which come under the scrutiny of scientific investigation for the first time. This state of things certainly renders the work highly interesting, but also very laborious, and from the very nature of the case throws upon myself personally a kind, and somewhat overwhelming amount, of miscellaneous work, from which I have only of late found some relief in the zealous and intelligent assistance of Mr. E. J. Wickson. It is a matter of much regret that the numerous interesting and important new lines of investigation suggested in the course of our work have so often to be dropped entirely for want of time to pursue them to a definite conclusion. As the demands upon us increase, there is a danger that it will become impossible to digest and utilize properly for the elimination of underlying principles, the multitude of facts elicited. To avoid this undesirable state of things, which already forms a subject of reproach to some of our experiment stations, it will be absolutely necessary to increase not only the working force of the station, but also to provide in it for men who can not only do the laboratory work according to instructions, but also discuss and determine for themselves, and for others, the bearings of the facts brought out. It is hardly necessary to insist that such men cannot be obtained or retained for the salaries of mere analysts.

Should the "Hatch experiment station bill" now before Congress become a law, the increased resources would permit of placing the work upon a much more satisfactory basis. Should help not come from this source, either an increase of means must be afforded by the State or else the scope of operations must be restricted so as to come within the limits of reasonable work for the present incumbents, without giving rise to the complaints of oversights or of excessive delay that more and more frequently come to us from persons whose cases, being more or less urgent, have not received attention for months after letters and specimens were received. Short-handed as we are at present, this is unavoidable, the more as the mere clerical work involved falls upon the analysts or upon myself, to the detriment of the progress of operations.

To keep the work in the general agricultural laboratory abreast of the demand, it would be necessary that another chemist should be steadily employed alongside of Mr. Morse.

In the viticultural laboratory one additional analyst is needed at least during the vintage season, especially if during that time laboratory instruction is to be given to students, as has been the case this season and will probably happen every year hereafter. When, as frequently occurs, from four to ten different lots of grapes come in daily, it is impossible to bestow upon the work the necessary care and to attend to instruction at the same time. In other words, if the State law on these subjects is to be properly complied with, such additional help must be provided for during at least three months, apart from the laborers, whose pay must be counted for about twice that period.

In regard to the rules governing the work in the general agricultural laboratory, it may be desirable to formulate them definitely, for the information of the general public, and perhaps, with a view to the inadequacy of our working force, to modify them somewhat.

The fundamental principle heretofore adopted, is that the work undertaken, and done gratuitously, should be of such a nature as to be of more or less public interest, and not merely for the benefit of individuals. Work of the latter nature, and falling properly within the line of work of commercial analysis, is not undertaken at all by the department.

In many cases, however, it is not obvious what may and what may not be considered as being of public interest. If the original intent of the work—that of obtaining as rapidly as possible an insight into the agricultural and industrial features of the State—be kept in view, then much that would otherwise be considered as being merely of a private nature, will fall within the limits of the public work. Thus, the nature and economic value of soils and waters forms a necessary part of an industrial survey, since these data bear directly upon the adaptation of the regions concerned for general or special culture, and upon the use of waters for irrigation or domestic purposes. It is a matter of grave public concern to know whether or not the waters of the wells and springs of certain parts of the State must be considered as usually detrimental to the health of the inhabitants, and whether or not such waters, if unfit, can be rendered fit for use by any simple process. This consideration amply justifies, in my view, the examination of such waters to the extent exemplified in Appendix No. I, Part II; that is, the ascertainment of the total quantity of mineral ingredients, and of their nature and proportions, so far as a skillful *qualitative* analysis can estimate them. A similar *general* examination is assuredly justified in the case of supposed mineral springs, adapted for the establishment of places of public resort. Detailed analyses, such as would serve for the advertisement of such waters, have thus far not been undertaken at all, being so laborious that their performance would encroach too heavily upon the work pertaining more directly to agriculture, so long as but a single assistant is employed.

The frequency with which such investigations are desired, however, plainly indicates the need of a thorough investigation of the waters of the State, for the benefit of the present and the incoming population. As a most important sanitary measure, the examination of the potable waters might very properly fall under the control of the State Board of Health; for the work heretofore done under my supervision in this direction plainly points to the fact that in very many cases the popularly reported unhealthiness of certain districts is due largely, and in some purely, to the unconscious use of unsuitable drinking waters.

In the matter of soils, one of two cases usually occurs. Either the soil is already known through a prior examination, and in that case a copy of the previous report on the same is sent to the applicant; or else the soil is unknown, or from an unexplored region, and in that case it is of public interest to have it examined; provided always that the samples be so taken as to exhibit properly the natural conditions, and that they represent a notable extent of country. These conditions are insisted on, and enforced by the sending of printed directions not only for the taking of samples of soils and subsoils, but also for giving as full a description of the circumstances of their occurrence, depth, natural vegetation, observed peculiarities in cultivation, etc., as it lies within the power of the applicant to give. No analysis is made unless these conditions are complied with. In this way each soil examination, whether accompanied by an analysis or not, becomes another definite point gained for the construction of a soil map of the State; and each one furnishes, in addition, some item of interest from the general standpoint of the agricultural chemist, corroborating or contradicting, as the case may be, some previously formed theory in respect to the functions of soil ingredients or of peculiarities of physical constitution.

As a rule the samples sent are examined in their turn, a regular docket being kept in the laboratory for the purpose. At times, when a short examination will determine all needful questions in the premises, a later

example is given precedence over one whose examination involves a delay of weeks or months.

Of late it not unfrequently happens that soil examinations are desired as preliminary to a purchase of land that is to be consummated within a short time, so that, if the examination were deferred until the regular turn of the sample came, it would come too late for the purpose for which it is desired. The case being then one of private interest so far as the urgency is concerned, it ceases to fall under the general rule, and should be made at private expense. Since, however, soil analyses accompanied by the necessary intelligent interpretation, do not form part of the work offered by commercial analysts, the only way in which the demand can be satisfied is by having it done by competent private parties within the University. Advanced or post-graduate students are generally found willing to undertake such work under my supervision, and act for time being as assistants temporarily employed at the expense of the applicants, the results of the work being guaranteed and interpreted by myself, as in other cases. The same policy is pursued when such work is asked for during vacations, when one or more of the assistants volunteer for the purpose. As the work so done is such as in its proper turn would be done gratuitously by the department, no objection can lie against this plan for supplementing the working force on pressing occasions. It would, of course, be desirable that an increase of the regular force should render it unnecessary to resort to this expedient, and enable us to pursue uninterruptedly some definite lines of general investigation, which are now forced into the background by the pressure of detail and routine work. If (as must soon happen) any considerable amount of work in the way of fertilizer analyses should be added, or if a State fertilizer control should be established, a very material enlargement of our working facilities would become imperative.

FIELD EXPERIMENTS AND GARDEN OF ECONOMIC PLANTS.

For a detailed account of the operations of this part of the experimental work, I respectfully refer to the reports of Mr. Wickson and Mr. Klee, under Appendices Nos. 2, 3, and 4. The facts elicited by Mr. Wickson's comparison and discussion of the reports on forage plants and cereals sent out from the University to various parts of the State, and Mr. Klee's summing-up of his observations on the merits and demerits of the numerous varieties of orchard fruits that have passed under his eyes during his connection with the University, are especially interesting, as are also the observations on wheats that are proof against the attacks of the Hessian fly. This work hardly needs any comment, as its utility is too obvious to be discussed, and I trust the usual appropriation of $7,500 per annum for two years will, as heretofore, be made toward the uninterrupted continuation of the practical work and instruction. I must, however, allude to some pressing needs that have long manifested themselves, and will not bear delay much longer.

1. The entire establishment of greenhouses is too small and imperfect for our purposes, and should be materially enlarged, both in horizontal and vertical space. Our best greenhouse plants must now be currently disposed of by exchange, so soon as they become of respectable size, because there is not room for them. We need at least twice the space we now have, in each direction.

2. The heating apparatus of the warm houses is in the last stages of decay, and, while it may be nursed through this season, will certainly not be able to resist another Winter. We have patched and repaired it con-

tinually, partly because the expense of a new apparatus could not be defrayed, partly because it was thought inexpedient to commit ourselves to the preservation of the utterly inadequate present accommodations by a new purchase gauged by its dimensions.

A structure reasonably adequate to our requirements would cost not less than $5,000, and would advantageously be extended to $8,000. If the needful amount cannot be obtained by appropriation, it might, perhaps, be obtainable as a gift from some public-spirited citizen.

3. Our propagating grounds are now full of trees and shrubs, originally provided for the purpose of stocking the campus with the same. A great proportion of these has now become so large that longer delay in transplanting them to a permanent site would mean their total loss. I therefore suggest that ground be prepared at the west and south base of the hill land in the rear of the University grounds, beyond the forest of eucalyptus and cypress, and that that portion of such land available for the purpose be set apart for use as an arboretum, to be properly laid off so as to afford opportunity for a pleasant extension of the present walks. The expense of this improvement could have been afforded out of the Agricultural Fund, but for an appropriation lately made therefrom by the Board of Regents for another purpose. As matters now stand it must remain alternative with another much needed improvement, viz.:

4. The underdraining of the agricultural grounds on at least three lines. I have repeatedly alluded to the need of this improvement, without which the best portion of the land constituting our experimental grounds remains useless for any comparative experiments, as, according to the season, it may or may not remain water-soaked until late in the season. The estimated expense of this underdrainage is about the same as that which must be incurred in planting the arboretum; and, perhaps, considering the loss that will ensue from a year's delay of the latter, it had better be given precedence.

All of which is respectfully submitted.

E. W. HILGARD,
Professor of Agriculture, etc.

APPENDICES.

I.

PAGE.

Report and Discussion of Work in the General Agricultural Laboratory 23

II.

Report on Grasses, Forage Plants, and Cereals 81

III.

Report on Economic Trees and Plants, and Tests of Fruit Varieties in the University Orchard 108

IV.

Report on Economic Entomology, Insecticides, etc. 140

V.

Report on Distribution of Seeds and Plants, and Donations Received 157

VI.

Report of the Viticultural Work During the Season of 1885-86, and Report of Progress for the Season of 1886-87.
(Published separately.)

VII.

Alkali Lands and Their Relations to Irrigation and Drainage.
(Published separately.)

APPENDIX I.

RECORD AND DISCUSSIONS OF WORK IN THE GENERAL AGRICULTURAL LABORATORY.

EXAMINATIONS AND ANALYSES OF SOILS, WATERS, AND MISCELLANEOUS SUBSTANCES.

I. ANALYSES OF SOILS.

A. Great Valley.

SOILS FROM THE "BEDROCK LANDS."

The great interest attaching to the border lands of the great valley for fruit culture, as the successor of the long-continued wheat, has led to the special examination of the several soil and subsoil layers of a region lying southeast from the city of Sacramento, in which the question arose whether the artificial breaking-up of the underlying hardpan would, as in the neighborhood of Fresno, pay well enough to be made a regular practice. The results of this investigation were published at the time in *Bulletin No. 44*, which is here reproduced:

The "Bedrock Lands" of Sacramento County.

The high quality of the fruit produced in the foothill lands of the Sierra is well recognized, and as time progresses a large proportion of these lands will undoubtedly be given to orchards and vineyards. The border lands of the great valley lying along their foot, that have thus far been mostly devoted to wheat growing, are likely to share the same fate, provided the expansion of the market for California fruits, now forming the subject of much anxiety and discussion, shall justify a corresponding enlargement of the area of fruit culture. The soil of these border lands varies from a grayish loam of alluvial character, occupying the lower ground, to a yellow or reddish soil which usually forms low broad ridges running from the foothills proper into the valley; the intensity of the tint increasing as the hills are approached, where the prevailing color is the proverbial "red" of the placer mines.

On the foothills from Butte south to Amador the adaptation of the soil to fruit and vine culture seems to be little more than a question of depth above the bedrock; although in numerous cases the latter is itself so soft that the roots of the hardier kinds, such as the vine, fig, olive, and carob, can without difficulty make their way into, and draw both moisture and sustenance from it. In the rolling border lands of the valley the soil, or rather subsoil, is usually of sufficient depth and penetrability for all purposes; but to this rule there are exceptions, in the local occurrence of tracts ranging from a few acres upwards, where an apparently impenetrable material underlies at depths varying from one to several feet; and although this material is altogether different from the slates underlying the foothill lands, the fact that it produces the same effect on the welfare of fruit trees has caused the local name of "bedrock lands" to be given to such tracts.

An able article, giving an account of the region in question, appeared in the "Sacramento Bee" in May last, and a few weeks afterwards a set of representative samples of soil, subsoil, and "bedrock" with underlying strata, carefully taken according to directions, was furnished by Mr. William A. Lawson, of the staff of the Bee, with the inquiry whether the lower layers would, if broken, contribute anything to the nutrition of trees. These

samples were from the neighborhood of Florin, Sacramento County, from which region a sample of surface soil had been previously sent by Mr. James Rutter, of Florin. About a month later, a corresponding set of samples were received from Mr. D. Lubin, of Sacramento, showing the state of things on some portions of Weinstock & Lubin's ranch, near Mayhew Station, on the Sacramento Valley Railroad. Although derived from localities several miles apart, the two sets agree very closely, and show the following arrangement of layers:

1. Pale orange surface loam, four to forty-eight inches thick.
2. Stiff brownish adobe, three to twelve inches thick.
3. Brown or whitish hardpan, one to ten feet thick.
4. Brown or white coarse sand, depth not known.

No. 1, the loam forming the soil and ordinarily the subsoil of the region, is apparently identical in the two localities, and is scarcely distinguishable from the soils prevailing *e. g.*, near Wheatland, Yuba County, in a corresponding position; it also agrees very nearly in the essentials of chemical composition.

The brown adobe, No. 2, which forms an almost uniform layer over the bedrock everywhere, has evidently been formed out of the latter, in the course of time, by the usual process of soil-formation, and, as will be seen below, the two scarcely differ in composition more than might different portions of either from each other.

The bedrock hardpan, No. 3, differs somewhat in aspect in the two localities. At Mayhew Station it is a yellowish-white, almost chalky, uniform mass, covered on top by a blackish, smooth, almost shiny crust an eighth of an inch thick, manifestly formed by the deposition of brown iron ore (limonite); it would, alone, effectually prevent the penetration of roots into the hardpan. The latter is quite compact and free from grit above, but downward gradually becomes more friable and sandy, and finally seems to pass into almost pure sharp sand, at times of a strong rusty tint, but mostly white. Mr. Lubin states that this rock crumbles on exposure to the air.

At Florin the bedrock is less compact, of a rusty tint, and instead of the hard, shining crust on the surface, it is penetrated in all directions by blackish streaks of the iron ore. It seems more nearly ready to form the adobe than the material at Mayhew, and is more readily penetrated by roots, but in general character is very nearly alike.

These differences account for some differences in the experience had in this bedrock land in regard to the success of orchard trees planted on it. It is stated that they flourish for a few years, varying with the depth of the soil, but about the time that the roots reach and would need to penetrate the hardpan layer, they cease growing and often finally die. The question arises whether this is due simply to the impenetrability of the bedrock, which prevents the roots from gaining access to a sufficient supply of moisture and plant food; or whether any injurious ingredients, or other conditions, play a part in the failure of the trees.

The analysis of the samples from Florin of the three successive layers—the surface loam*, adobe, and hardpan or bedrock—gave the following results:

"Bedrock Lands"—Soil, Subsoil, and Hardpan.

	No. 858. Soil.	No. 949. Adobe Subsoil.	No. 959. Bedrock Hardpan.
Coarse material	4.80	----------	----------
Fine earth	95.20	----------	----------
Chemical Analysis.			
Insoluble matter	82.94	72.07	72.65
Soluble silica	6.28	7.50	6.12
Potash	.28	.38	.43
Soda	.07	.16	.14
Lime	.60	.52	.61
Magnesia	.23	.64	.95
Br. oxide of manganese	.09	.02	.02
Peroxide of iron	1.91	5.10	5.65
Alumina	5.42	9.44	9.31
Phosphoric acid	.02	.04	.08
Sulphuric acid	.01	.01	.01
Water and organic matter	2.26	4.12	4.08
	100.10	100.02	100.05
Humus	.46	----------	----------
Available phosphoric acid	.01	----------	----------
Hygroscopic moisture	2.66	7.67	8.70
Absorbed at 14° C.			

*Sample sent by Mr. Jas. Rutter.

It is curious to note in the above analyses, that, notwithstanding the great differences in the appearance of the three materials, they do not differ widely in most points of their composition. The prominent points of difference are that the surface soil contains about ten per cent more of inert matter (fine sand) than the other two, but much less iron, and only a very minute amount of phosphoric acid. The latter, however, increases very rapidly downward, the adobe containing more than twice as much as the top soil, and the "bedrock" again nearly twice as much as the adobe, or four times as much as the surface soil. The deficiency of the phosphoric acid in the soil is measurably offset by the fact that nearly all of it (.016 out of .019) is in an available condition, and hence the deficiency has not been much felt in the past; yet it does seem quite important that the relatively large supply in the lower depths should, if possible, be rendered accessible to the roots of trees. The supply of lime is nearly the same in all, and probably adequate, although more would be desirable in the stiff adobe.

It is certain that this desirable downward penetration of tree roots is not possible, when, as near Mayhew Station, they encounter a hard, polished crust, covering a very solid hardpan of several feet depth; and while at Florin the hard crust is less prominent and the material less solid, yet its condition indicates a want of drainage during the wet season, causing the formation of iron solutions, injurious to the root tips, exactly as in the other locality. It is obvious that the roots cannot go far during the season through such a substratum; and the breaking up of the latter by some financially practicable method would seem to be the necessary condition for the success of orchards.

Messrs. Weinstock & Lubin have attempted this on a somewhat extensive scale on their ranch near Mayhew. Mr. Lubin describes the process as follows: "A hole five by six feet and six feet deep was dug for each tree. It is necessary to blast the bedrock layer with giant powder; even when using from three to five sticks much picking has to be done, in order to shatter thoroughly the several sedimentary layers. The work thus done is quite thorough, but very costly, ranging from $65 to $75 per acre. Messrs. Kroll and Rutter simply drill a hole with auger, put in a charge of black powder, which blasts a little rock, and then plant their trees. Query: Will this be sufficient in the long run? It would cost only about $30 per acre, and would be cheap at that if the land could thus be made to grow Bartlett pears and the like."

It certainly seems very desirable to avoid the heavy expense of digging through the bedrock; and if it can be sufficiently shattered by blasting at the bottom of a borehole, all that is really needful will have been accomplished. A charge of common black powder is not likely to do this; while on the other hand, so high an explosive as dynamite would not be sufficient in its pulverizing action, as is shown by the use of so many cartridges in one hole by Mr. Lubin. I therefore suggested the use of "Judson powder" in a borehole of sufficient depth, and the subsequent digging of the holes to the usual depth only.

In a late communication Mr. Lubin states that Judson powder does not do sufficient execution in the "bedrock," and that giant powder No. 2 seems preferable. The kind of explosive to be used with the greatest advantage will naturally vary from place to place, with the nature of the hardpan, and will have to be ascertained by trial—which could best be made before the rains set in. But in view of the fact that the substratum of the "bedrock lands" is shown to be actually richer in plant food than the surface soil; that while in its natural condition it not only obstructs the passage of the roots mechanically, but also injures them by the formation of poisonous solutions in consequence of the stagnation of water; all of which can be relieved by the shattering of the substratum by means of judicious blasting, also giving the roots access to abundant moisture: it would certainly seem that in favorable locations, where land is valuable, this mode of rendering it available for fruit culture deserves most earnest consideration. Neither the adobe nor the "bedrock" should be used in the filling up of holes after planting, any more than a raw subsoil should be turned on the surface in other cases. But with the access of air and water to the shattered portion, the substrata will gradually go through the processes of soil formation; and their plant food will doubtless become available fast enough to insure the welfare and productiveness of an orchard for the usual period.

Berkeley, October 2, 1885.

SOILS FROM THE TULARE LAKE BORDER.

Several analyses of soils from the neighborhood of Tulare Lake, representing substantially the deposits of that basin, have been heretofore published. Thus far the alkalinity of the soils has somewhat restricted the use of these lands; but the discovery that artesian water of remarkable purity can be obtained at moderate depths in a part of that region adds new interest to the question of their quality, since by the aid of reasonably pure irrigation water and a proper system of drainage the alkali trouble can be measurably relieved.

The two soils first given in the table below were analyzed by Mr. Geo. E. Colby, by the desire of Mr. Geo. E. Raymond, the proprietor, by whose consent they are here reported.

No. 891 is from the higher land on S. 23, T. 25 S., R. 23 E., southeast from Tulare Lake, in Kern County. It is a fawn-colored loam, of fine texture, easily tilled. A large artesian well is on the same section.

No. 893 is from low ground on S. 31, same range and township. When dry it is a pale bluish-gray clay, cleaving in angular fragments; very smooth, plastic, and adhesive when wetted; evidently a lagoon deposit formed in quiet back water.

In both cases the material is the same for three or four feet downward.

For comparison there is placed alongside a soil from the immediate shore of the lake, sent by Mr. E. R. Thomason, August 12, 1878.

The specimen was taken from the reclaimed "swamp and overflowed" land, on the east side of Tulare Lake; is inclosed by a levee, and lies below the high-water mark of the lake; eighteen months before it was all under water, but at the time of taking the sample the water was half a mile from the levee. The first vegetation that started after it was laid dry was "wild parsley," followed later by wire grass, salt grass, and tule. The surface at the present time shows no salt and but little indication of alkali. Grain, however, "burns up" when hot weather comes, even though the ground be moist. Garden vegetables look well until blooming time, and then die.

When sampling the soil at the time stated, it was found to be baked, quite hard for the first six inches; from that line down to twenty inches, to which depth it was taken, it was "boggy and soft." The soil as received is a somewhat bluish-gray clayey sediment, containing a good deal of small gravel and shells intermixed. Its reaction is alkaline, though not sharply so.

TULARE LAKE ALLUVIAL SOILS.

	No. 891. Soil.	No. 893. Soil.	No. 77. Soil.
Coarse materials > 0.5mm			
Fine earth			
Analysis of Fine Earth.			
Insoluble matter	54.71 } 64.55	56.92 } 67.65	67.34
Soluble silica	9.84 }	10.72 }	
Potash (K_2O)	2.02	1.66	1.05
Soda (Na_2O)	2.73	.54	.84
Lime (CaO)	2.46	2.96	6.51
Magnesia (MgO)	2.93	3.12	3.96
Br. ox. of manganese (Mn_3O_4)	.03	.04	.04
Peroxide of iron (Fe_2O_3)	7.41	6.73	5.05
Alumina (Al_2O_3)	11.50	10.35	7.97
Phosphoric acid (P_2O_5)	.11	.17	.32
Sulphuric acid (SO_3)	.01	.01	.08
Carbonic acid (CO_2)	1.87	.93	4.42
Water and organic matter	4.34	5.76	3.71
Total	99.90	99.93	101.29
Humus		.38	.47
Available inorganic		1.03	2.18
Hygroscopic moisture	8.63	10.53	
Absorbed at 10° C.			

Although differing considerably in the figures of some of their ingredients (No. 891 containing twice as much potash and three times as much soda as 77, and the latter nearly three times as much lime and phosphoric acid as the former), yet in their general character all alike are rich soils,

which if drained and freed from their excess of alkali would under cultivation become exceedingly productive. No. 893 is of so extreme a physical character—approaches so nearly to a potter's clay in its excess of that ingredient—that it may be doubted whether it would ever be properly tillable. Yet under the corrective influence of gypsum to neutralize the carbonate of soda, even it might become capable of bearing at least certain crops.

It is not easy to overestimate the importance of reclaiming to general culture the lands of the Tulare Lake border that have been laid dry by the recession of the lake. But only discouragement can result from undertaking to do this without taking into account the peculiar nature of these soils, and conforming to their need for peculiar treatment if they are to respond to the efforts of the husbandman in a manner commensurate with their abundant native resources. As this subject is treated extendedly in Appendix No. 5 to this report, it is unnecessary to enlarge upon it further in this place.

EXAMINATIONS OF ALKALI SOILS.

Requests for the examination of alkali soils with reference to their correction for cultivation are becoming more and more frequent as land becomes more valuable and the great intrinsic fertility of this class of soils, a natural consequence of their origin, is recognized. It is extremely important that samples sent should be so taken as to represent the true average, and not merely an accidental accumulation, when instructions as to the measure of possible antidotes are desired.

No. 1004. Alkali soil from Courtland, Sacramento County. Sent by Mr. W. E. Gammon. Of this soil the sender says: "This soil is commonly known here as 'alkali' land. It will produce scarcely anything except one kind of grass (*Distichlis*, 'alkali grass'). All other vegetation, if it does barely live, has a yellow, sickly appearance. Trees can live but a few years, and do not grow at all, seemingly. During the dry season these portions become quite a little lighter colored. Soil showed no difference in color to a depth of four or five feet." The soil is a sandy loam of rather fine texture, almost silty, easily crushed between the fingers when dry, and of a pale yellowish tint. It shows no obvious saline taste. On extraction with water it yielded a turbid solution which would not clear by standing or filtration, and was therefore evaporated in that condition. The determination gave:

Soluble extract from air-dried soil	.12 per cent.
Again soluble after evaporation	.043 per cent.
Insoluble after evaporation	.042 per cent.
Organic matter and loss	.034 per cent.

The soluble portion of the extract was quite strongly alkaline, and consisted in the main of carbonate of soda, with a little common salt and potassium chloride. The part remaining insoluble after evaporation, consisted largely of clay that had passed the filter, with some carbonate of lime and a little magnesia. It thus appears that, contrary to the first impression, this soil is really contaminated with enough of "black alkali," or alkaline carbonates, to be materially injured in its agricultural qualities thereby. It would seem that the very fact that the soil contains but little clay, renders the very minute amount of alkali effectual in causing sterility. It is possible that the soil is in itself very poor in plant food, a point still to be tested by analysis. But, in any case, it is advisable to try the effect of a

dose of land plaster—say two hundred pounds per acre—in improving the production and tillage of the soil and neutralizing the carbonate of soda. From analyses heretofore made of similar soils from this region, it is probable that the above is also very deficient in phosphates, and would be greatly benefited by a dressing of bone meal.

No. 859. Alkali soil, from East Park, Sacramento City, taken and sent by Mr. James Rutter, of Florin, Sacramento County, together with a sample of the ordinary soil of the region, with the query whether the alkali soil is so constituted that by a free or moderate use of the same on the other it will act as a fertilizer, or otherwise beneficially, especially with reference to the production of grapes.

The alkali soil is a buff colored, rather sandy loam; contains roots and stems of "alkali grass." It yields to water 2.88 per cent of saline matters, which on evaporation and ignition of the residue give the following result:

	Per Cent.
Again soluble in water	76.2
Insoluble	9.7
Organic matter and combined water	14.1
	100.1

The soluble part, forming 2.2 per cent of the soil, is composed as follows:

Chloride of sodium	68.73
Carbonate of soda	22.49
Sulphate of soda	8.82
	100.00

The insoluble part, being .31 per cent of the soil:

Carbonate of lime	7.92
Carbonate of magnesia	34.49
Gypsum (sulphate of lime)	4.29
Iron oxide and some clay	45.05
Silica	8.25
	100.00

According to this analysis, the soil sample contained in its permanently soluble portion only salts of sodium, none of which can be considered as being of any material value to vegetation; the carbonate being, on the contrary, an injurious ingredient, and present to the extent of over seven tenths of one per cent. Only traces of potash and phosphoric acid exist in the soluble part; and the lime the insoluble portion carries with it would be insignificant. Thus it could not be beneficial to any soil to which it should be applied as a fertilizer. On the contrary, in order to destroy the injurious carbonate of soda, the Sacramento alkali soil should be treated with a proper dose of land plaster, which would transform the carbonate into the relatively innocent sulphate, or Glauber's salt.

No. 917. Alkali soil, from Sec. 4, T. 26, R. 23 E., on the south border of Tulare Lake, Kern County; sent by Mrs. A. S. Moore. A thin crust of alkali is said to cover this soil during the dry season. On leaching with water it yields to the latter 2.3 per cent of soluble matter. The solution is slightly turbid and somewhat alkaline, indicating the presence of carbonate of soda. The bulk of the salts dissolved, however, consists of sulphate and chloride of sodium, or Glauber's and common salt. The soil would undoubtedly be benefited by the application of gypsum to neutralize the carbonate of soda, but would apart from this require all the precautions in cultivation that are elsewhere described for alkali soils in general. See Appendix No. 7 to this report.

No. 965. Surface soil, from Easton, Fresno County; sent by Mr. L. Hanson, of that place, for examination as to the kind and amount of alkali contained therein, and the proper treatment of the soil in cultivation. The soil is a fine, silty one, of the usual character of the soils occurring to westward of Fresno. On extraction with water, the soil yielded to the latter 1.68 per cent of saline residue. Of this there was:

Again soluble after ignition	1.116 per cent of soil.
Insoluble	0.474 " "
Water and organic matter	0.096 " "

Or, calculated to per cent of the total residue:

Again soluble	66.18 per cent.
Insoluble	28.13 " "
Water and organic matter	5.69 " "

0.93 per cent of the total residue was silica.

The soluble part was but very slightly alkaline, and consisted essentially of the sulphate and chloride of sodium, or Glauber's and common salt, with a small proportion of potash, lime, and magnesia. The portion left insoluble upon evaporation and ignition consisted of the carbonates of lime and magnesia, with some silica. The alkali of this soil is accordingly of the milder sort, which does not require treatment with gypsum, but may probably be dealt with by a proper method of cultivation.

B. Sierra Foothills.

Nos. 976 and 977. Soil and subsoil from the neighborhood of Colfax, Placer County, sent by Mr. M. Lobner of that place. The country rock in this neighborhood is slate, which, according to Mr. Lobner's statement, is always found to be standing on edge or slightly slanting from the perpendicular, and being, as the samples sent show, very much decomposed to a considerable depth (rarely hard and bluish), it is readily penetrable by roots. It lies at depths varying from ten to forty inches below the surface, is of a grayish-white tint, and is directly overlaid by a bright orange subsoil—a clayey loam mingled more or less with fragments of bedrock, the latter decreasing toward the surface until in the brownish-red surface soil, which forms a layer averaging about six inches in thickness, but very little rock material can be seen. The soil is easily tilled, and when well cultivated always shows moisture at a depth of from two to four inches during the dry season; hence no irrigation is needed. The natural growth is the foothill pine, black oak, and manzanita, with some chaparral, and very generally some "tarweed" (in this case the *Chamaebatia foliosa*, a member of the rose family, which prevails extensively in the central and northern foothills of California).

The change of the surface soil to the color of the subsoil occurs at from four to five inches in depth; but, according to directions, the surface soil sample was taken to the depth of six inches. Only a partial analysis of this layer was made, the most important material in connection with cultivation being manifestly the subsoil.

SOIL AND SUBSOIL FROM COLFAX.

	No. 976. Soil.	No. 977. Subsoil.
Coarse materials > 0.5mm		21.2
Fine earth		78.8
Analysis of Fine Earth.		
Insoluble matter		67.69 } 75.74
Soluble silica		8.05 }
Potash (K_2O)		.49
Soda (Na_2O)		.14
Lime (CaO)		.25
Magnesia (MgO)		.53
Br. ox. of manganese (Mn_3O_4)		.18
Peroxide of iron (Fe_2O_3)		3.8
Alumina (Al_2O_3)		13.32
Phosphoric acid (P_2O_5)		.03
Sulphuric acid (SO_3)		.03
Carbonic acid (CO_2)		
Water and organic matter		5.41
Total		100.00
Humus	2.10	
Available inorganic	0.58	
Available phosphoric acid	0.02	
Hygroscopic moisture		6.01
Absorbed at 16° C.		

This analysis shows the soil to contain a good supply of potash; and in the surface layer an abundance of humus, contrary to the impression conveyed by the color of the soil. The supplies of lime and phosphoric acid are not high, and cereal culture would soon exhaust the latter, of which, nevertheless, one third is in an available condition in the surface soil. But the whole character of the soil is such as to insure a high quality in fruits adapted to the climate, and in view of the abundant supply of moisture and depth of soil overlying the pervious bedrock. The land would, undoubtedly, be very durable under such culture when rationally conducted. Lime and bone meal will be the fertilizers to be first applied to this soil when its production begins to languish.

Nos. 861 and 863. Soils from the neighborhood of Grass Valley, Nevada County. Sent by Mr. H. H. Hanssen, of Grass Valley, who thus describes their characteristics:

"No. 861 is the predominant soil around Grass Valley, and to the south and southeast. It covers all the hills that have a bedrock formation of slate or granite. The soil and subsoil layer varies in thickness from one to four feet, sometimes with a clayey subsoil, but oftener such soil as the sample lies directly upon the rock. The latter, especially in the case of granite, is soft and broken up, and admits roots readily to the depth of eight to ten feet. Trees and vines grow in it without irrigation. The natural growth is yellow and sugar pine, white, live, and scrub oaks, manzanita, and chaparral. When cultivated in grain and vegetables this soil does well for a year or two, after which crops are a failure unless manure is used; with the latter it does well."

The soil is a light loam, rather silty than clayey, of a red tint; dry lumps crush easily between the fingers. When wetted the color darkens considerably, and the soil becomes only slightly plastic, showing but a small

amount of clay. Some angular rock fragments, and gravel up to duck-shot size, are intermixed.

"No. 863, taken from the farm of D. Bryan, is the soil overlying the ancient gravel deposits, which are covered by it, sometimes with a lighter-colored clayey subsoil, to the depth of six to ten feet, when a "cement" formation is struck. It occurs chiefly to the northward and eastward from Grass Valley; in fact, it covers all the hills under which the auriferous gravel beds are found. Sometimes the gravel cement comes to, or near the surface, when the ground becomes gravelly and barren. Its vegetation is of ranker and coarser growth than on the other soil. The normal forest consists of spruce, cedar, fir, different kinds of pine, and some black oak."

The color of this soil is deeper than that of the first one, but apart from a larger proportion of gravel, its physical character is about the same.

SOILS FROM NEAR GRASS VALLEY.

	No. 861. Soil, 12 in.	No. 863. Soil, 12 in.
Coarse materials > 0.5mm	12.66	5.6
Fine earth	89.34	94.4
Analysis of Fine Earth.		
Insoluble matter	43.81 } 55.18	26.96 } 37.91
Soluble silica	11.37 }	10.95 }
Potash (K_2O)	.16	.15
Soda (Na_2O)	.17	.21
Lime (CaO)	1.29	.33
Magnesia (MgO)	2.19	.30
Br. ox. of manganese (Mn_3O_4)	.03	.07
Peroxide of iron (Fe_2O_3)	8.25	8.25
Alumina (Al_2O_3)	21.87	36.38
Phosphoric acid (P_2O_5)	.03	.10
Sulphuric acid (SO_3)	.10	.07
Water and organic matter	11.16	16.48
Total	100.43	100.25
Humus	2.37	2.89
Available inorganic	.71	.76
Available phosphoric acid	.02	.05
Hygroscopic moisture	8.19	14.19
Absorbed at 17 C.		

These soils are of very unusual composition, especially for California. Their prominent features are a remarkably scanty supply of potash, an ingredient which is usually not only in ample supply but often in excess in the shape of soluble "alkali." The percentages here shown would be considered as indicating a deficiency, even in the Eastern States, and there can be little doubt that the quick giving out of the soils under cultivation, as reported by Mr. Hanssen, is due to this, the exhaustion of the available potash; for while in No. 861 the phosphoric acid forms a very small percentage, it is shown to be nearly all in the available form; in No. 863 there is quite a large supply and half of it is in the soluble state. Lime is in large supply in No. 861, while only one fourth as much exists in No. 863, yet that amount is above deficiency. Humus is abundant in both, and with it presumably the supply of nitrogen is sufficient.

Potash fertilizers, like "kainite," are clearly indicated for the improvement of these soils.*

C. Southern Region.

Nos. 809–812. Soils and subsoils from Riverside, San Bernardino County; sent by Mr. Geo. L. Waring, of Riverside. Regarding the general character of the soils of the region, Mr. Waring makes the following statements: "The soil here is generally supposed to be produced by the decomposition of granite, as granite rocks abound in the neighborhood, and small pieces of granite are often turned up by the plow. When wet the soil is of a chocolate color, hard and gritty in character, and when flooded and not subsequently broken up it "bakes" very hard. The stiffer land is rather hard to work and unfriable, but where more sand is present it can be broken up into very small particles. In wet winters alfilerilla grows abundantly, and also a bunch grass with light, bright green leaves and a pink flower. Lupins and many other wild flowers also grow. I have noticed milk thistle on cultivated ground. There is a good deal of brush in some places.

"As fruit growing is the main industry here, and as it is carried on by the process of irrigation, the surface soil, except as to its mechanical texture, is of less importance than the subsoil. In the localities where the samples were taken the soil layer is about eight feet deep and then underlaid by sand."

In aspect the several samples sent do not differ very widely, being of a brownish dun color when dry, with a considerable admixture of angular granite sand and gravel up to buckshot size, and a good deal of shining mica particles. Considering the general aspect and texture of the soils, the amount of coarse sand shown on washing is surprising. The surface soil might mostly be called a coarse sandy loam.

The subsoil is partly light, with much mica, evidently where the sandy layer mentioned intermingles with it; but in most cases it is heavier than the surface soil, and quite stiffish, so that when dry the lumps cannot be crushed with the fingers. When wetted it works quite "heavy," evidently owing to the fact that there is but little fine sand to lighten the clay that binds the coarse particles of granite together.

Of the specimens sent, the surface soil taken at the depth of six inches was not analyzed, but only subsoils. The exact depth at which these were taken is not given by Mr. Waring; of the two analyzed, No. 809 represents the lighter, No. 812 the heavier variety, and probably also, at some points, a higher and lower layer, respectively:

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*A very remarkable feature of both soils is the large amount of alumina dissolved in the analysis, which ordinarily would be held to indicate an extremely clayey soil; whereas neither soil can take rank otherwise than as a rather light loam. It would be of great theoretical interest to determine the combination in which the alumina exists in these cases. The large loss by ignition points to the existence of the alumina in the shape of hydrate (gibbsite, or beauxite), since the soluble silica found is not nearly sufficient to form kaolinite. That such soils, with so little potash, could be formed from any rock deserving the name of granite, is also singular.

RIVERSIDE SUBSOILS.

	No. 809. Lighter Land.	No. 812. Heavier Land.
Coarse sand	37.6	26.6
Fine earth	62.4	73.4
Insoluble matter	78.36	68.34
Soluble silica	5.62 } 83.98	7.10 } 75.44
Potash	.79	.97
Soda	.56	.31
Lime	1.51	1.65
Magnesia	1.24	1.68
Br. oxide of manganese	.28	.04
Peroxide of iron	3.70	3.64
Alumina	6.68	10.19
Phosphoric acid	.11	.04
Sulphuric acid	.05	.03
Water and organic matter	1.66	2.41
Total	100.46	99.96
Humus	.11	.19
Available inorganic	.31	.39
Hygroscopic moisture	2.61	5.47
Absorbed at 14° C.		

These analyses fully confirm the suggestion made by Mr. Waring, that the soils of Riverside must be rich in potash; the percentage being very close to that found in the Pomona soils heretofore examined. Lime also is in full supply, yet, on the heavier soil, the application of lime might be made to facilitate tillage, though not requisite for fertilization. In phosphoric acid, curiously enough, the lighter soil exceeds the heavier by more than double, the latter being near the limit of deficiency, while in the lighter the supply is a good one. Both samples examined being subsoils, it is not surprising that their supply of humus should be small. In the surface soil doubtless it would have been found to approximate that found in the soils of Pomona and Redlands (see report for 1884, page 56), viz., between three and four tenths of one per cent (.35 per cent), or about half as much as is desirable in upland soils. The system of culture should tend to remedy this deficiency, which will doubtless call for the use of Chile saltpeter before many years. In other respects, however, the Riverside soils are evidently quite substantial, and their depth, as well as the natural underdrainage by the sandy substratum, justifies the claim of their special adaptation to fruit culture.

No. 1023. Gravelly adobe subsoil; sent by C. F. Stamps, Orange, Los Angeles County. Taken from a depth of twenty-four inches, but not differing greatly in appearance from the surface soil. "The general characteristic of the soil is that it is loose and mellow the first few years that it is cultivated, but the longer it is worked the harder it becomes, especially if no weeds are plowed under in the winter. It works up very well after irrigation, if cultivated in time; if not, it bakes and becomes almost like cement, when it can hardly be broken with a pick. It holds moisture well when thoroughly cultivated. It is naturally a very dry and warm soil. This subsoil is taken at a depth of two feet, just where the color changes to brown. The brown color of the soil continues for a depth of seventy-five feet, but it becomes coarser as a depth of seven feet is attained." The

aspect and touch of the soil show it to consist of a large proportion of coarse sand and gravel, mixed with a quite heavy, yellowish clay. Only a preliminary examination being made, the soil extract made in the usual manner gave:

Lime	.47 per cent.
Phosphoric acid	.08 " "

The small proportion of lime thus shown in so heavy a soil sufficiently explains its difficult tillage after the natural tilth has been destroyed in cultivation. Its supply of phosphoric acid, and doubtless that of potash, is quite adequate, but would doubtless become more available by liming the land, which would also overcome the difficulty of tillage. The soil is obviously poor in humus and should be green-manured, an operation that would likewise tend to relieve its heaviness and tendency to bake. Above all things it should never be left untilled after irrigation, and therefore be planted to crops that admit of summer cultivation.

D. Southern Coast Range.

No. 912. Piedmont hills soil, from the land belonging to the "Ladies' Silk Culture Society of California," on which the United States silk culture experiment station has been established.

This locality, as its name implies, is just within the foothills of the Contra Costa Range, about two miles east of the city of Oakland, from which it is easily reached by a horse-car line. The land of the society includes part of both slopes of a ridge, from which a magnificent view of the bay and the Golden Gate is had, and, east of the ridge, the head of a small valley, which, with the east slope of the ridge, includes the best soil of the tract, and is now being cleared for planting with mulberry trees. A scattered growth of live oaks formed the original timber, but the tract was some years ago planted with eucalyptus trees, whose vigorous growth indicates at once the good quality of the soil. The latter, however, is altogether different from that which prevails on the hills near Berkeley. There we have almost throughout the various modifications of adobe, or more or less refractory clay loams; while at Piedmont the underlying sandstone has produced a substantial but still quite light sandy loam, easily worked, and penetrated by roots down to and even into the soft rock underlying at various depths. The dark mouse-colored surface soil is usually from twelve to twenty inches deep, when the color changes to a more yellowish tinge, and finally to the yellow of the sandstone itself. It should be stated that the latter dips at a steep angle to the northeast, so that all the moisture of the ridge is shed toward the east slope and valley, where the mulberry plantation has been established. Hence, the valley soil is more or less moist all summer, and offers an excellent site for nursery beds.

A sample of the soil was taken about the middle of the eastward slope to the depth of twelve inches. The color, however, remains unclianged to about twenty inches. The soil is quite friable at all times, and can readily be worked the day after a rain. Its analysis resulted as follows:

No. 912—Soil from Piedmont Hills.

Coarse materials		5.8
Fine earth		94.2
		100.0
Insoluble matter	78.43	84.22
Soluble silica	5.80	
Potash		.58
Soda		.19
Lime		.72
Magnesia		.56
Br. oxide of manganese		.19
Peroxide of iron		2.21
Alumina		6.07
Phosphoric acid		.05
Sulphuric acid		.02
Carbonic acid		----
Water and organic matter		5.54
Total		100.35
Humus		2.18
Available inorganic		.88
Available phosphoric acid		.05
Hygroscopic moisture		4.72

Absorbed at 15°.

The coarse material of this soil consists in the main of angular fragments of the underlying sandstone, with some coarse grains of sand. It is emphatically a "colluvial" soil.

As regards its chemical composition, the plant-food percentages are very satisfactory for a soil of so sandy a nature as to yield over 84 per cent of inert matter. Potash and lime are both in good supply, while that of humus is large. The phosphoric acid percentage is low, as it is in nearly all the ridge soils of the bay country; but here again, as is the case of the Pacheco Valley soil, practically the whole of it is in a soluble, or at least available condition, a feature connected, as it seems, with the prevalently high supply of lime and humus within the redwoods region.

Nearly all the mulberries are at home on calcareous soils; the American species will even flourish on the most refractory adobe or prairie soils, provided there is abundance of lime and humus. For so sandy a soil as that at Piedmont, the supply of both is quite high; and as the land will be readily and cheaply kept in good tilth, its adaptation to the growth of the mulberry, and to the general purposes of a silk culture experiment station, seems to be as good as could readily be found under the circumstances surrounding its establishment.

Marsh soils from near Seminary Park, Alameda County; sent by Mr. Byron Jackson, of San Francisco, with request to ascertain their probable availability when drained. The soils were leached to ascertain the amount of soluble salts therein. This leaching occupied a long time on account of difficult filtration, the solution being of a dark brown tint in both cases. In evaporating the extracts it was noted that there was a sensible giving-off of ammonia; hence a weighed amount of carbonate of soda was added to drive off all the ammonia, and the organic matter was then determined by burning-off from the residue. The following shows the somewhat extraordinary outcome of the examination:

	No. 814. Soil 6 in. Depth.	No. 815. Soil 1 to 24 in.
Soil extract, dried at 100°	37.1	10.7
Organic matter in same	6.7	10.7
Ammonia in soil	4.7	not det'd.

The ignited residue consisted almost wholly of soluble salts, which therefore constitute over thirty per cent of the soil material, No. 814. They contain besides common salt as the predominant ingredient, a large amount of sulphate of magnesia and some chlorides of magnesium and calcium. The extracts contained in combination respectively:

Chlorine	20.1	13.9
Sulphuric acid	3.5	3.0

A more exhaustive examination was not thought necessary, as it appears that the saline ingredients are present in such unusual quantities, and are in part so unusual in kind, as to render the present prospects of profitable reclamation for culture somewhat doubtful. The presence of so large a proportion of ammonia is most unexpected and points to some special source of supply, such as sewers conveying gas water, or other sewage unusually rich in that ingredient. The material as it stands might be used as a source of ammonia for commercial or fertilizing purposes, if in sufficient supply. But it seems hardly credible that such a state of things should extend over any large area.

Subsequent information received from Mr. Jackson, as well as samples of barley grown in the neighborhood, show that the samples above examined were accidentally taken from exceptional places. The barley was of extraordinary size and showed very clearly its development under the influence of an unusual supply of nitrogenous food, being leafy and stocky to a degree that would rejoice the heart of a haymaker, although probably the yield of grain would not be proportional to the luxuriance of the plant. Doubtless with proper drainage and precautions in cultivation, the average land can be profitably cropped, and certainly gives extraordinary promise of fertility.

PACHECO AND IGNACIO VALLEY SOILS.

[Pacheco and Ignacio Valleys lie respectively around the northern and western base of Mount Diablo, and form level plains dotted, or sometimes well wooded, with oaks.]

No. 882. Soil from Pacheco Valley, Contra Costa County; sent by S. Farjeon, editor Concord Sun, Concord.

This specimen represents one of the prominent soil features of the upper Pacheco Valley, which lies around the landward northern and western base of Mount Diablo, bordered by an outlaying spur of the Contra Costa Range. Beyond this spur, to the northwest, lies the Ignacio Valley, the western branch of the Pacheco plain, which, lower down, forms an uninterrupted body of splendid farming land from four to five miles wide between the western foothills of Mount Diablo on the southeast and the Contra Costa hills on the northwest. Along or near the base of the latter meanders Walnut Creek, the principal stream of the valley. Mount Diablo Creek, heading on the mountain itself, drains the eastern portion, joining.

Walnut Creek just before its entrance into the tules of Suisun Bay, where the united streams assume the name of Pacheco Creek.

The plain is dotted with large white oaks, which are especially thick near the borders of the streams. Close to the latter we generally find streaks of heavy black adobe, but farther away the soils are mostly lighter both in color and texture, and more or less intermingled with gravel. Sometimes "gravel ridges" of greater or less width indicate the course of ancient channels, and gravel evidently underlies a considerable portion of the plain, facilitating its drainage. This is the more important as the prevalent character of the soils is that of clay loams, passing locally into a pretty tough adobe.

Regarding the land represented by the soil specimen under examination, Mr. Farjeon states that, while it is taken to the depth of twenty inches, wells dug in the neighborhood show no change of tint to the depth of sixty feet; showing an enormous accumulation of an evidently alluvial soil mass. "Within a mile, or thereabouts, of the point where the sample was taken, there is an occasional change to a kind of coarse sandy and gravelly adobe, of black or brown tint. Cereal crops around this place, wherever sown, have been very good; and fruit trees and vines, wherever set out, are doing finely, and where old enough, have borne heavy crops of fruit, equal in flavor and size to any grown elsewhere. Rains throughout this valley have always been good."

The sample sent is a brownish-gray clay loam, of which dry lumps cannot easily be crushed between the fingers. On wetting, the lumps soften quickly and without change of tint, and when worked the earth becomes quite adhesive. The coarse portion consists mostly of flattened particles of hard shale and quartz, well rounded on the edges.

The analysis of this soil resulted as follows:

No. 882—Pacheco Valley Soil.

Coarse materials		10.75
Fine earth		89.25
Insoluble matter	63.28	72.12
Soluble silica	8.84	
Potash		.77
Soda		.57
Lime		1.69
Magnesia		2.36
Br. oxide of manganese		.17
Peroxide of iron		4.91
Alumina		12.86
Phosphoric acid		.06
Sulphuric acid		.01
Carbonic acid		-----
Water and organic matter		5.03
		100.55
Humus		1.07
Available inorganic		.90
Available phosphoric acid		.06
Hygroscopic moisture		9.05

Absorbed at 14° C.

The proportion of coarse material (gravel and coarse sand) shown in the above table is quite small, and probably below the average of the Pacheco plain, outside of the adobe streaks. Probably, however, the gravel percentage increases here, as elsewhere, with increasing depth, so as to render the subsoil easily penetrable to roots.

Chemically the soil shows a large supply of potash and of lime; and, as regards the latter, there can be no doubt that it is a general characteristic of the Pacheco Valley soils, since lime is abundant in the rocks on the flanks of Mount Diablo, as well as on the Contra Costa Range. On the banks of Walnut Creek, the lower portion of the adobe, just above the gravel that underlies at some five feet depth, is full of "white gravel" or lime concretions.

The proportion of phosphoric acid is not high, although it would in any case be accounted above deficiency. But the determination of its solubility shows (under the head of "available phosphoric acid") that practically all of it is in the available state, so that, for the present purposes, its supply is as high as that of soils showing a much larger aggregate percentage. The soil has also a fair supply of humus, and therefore, at present, of nitrogen. Its power of absorbing moisture is high, and, with its depth, constitutes a safeguard against drought and hot winds.

If, as it seems probable from its agreement in character with other soil samples from the Pacheco region, this soil is a fair index of the general character of the latter, its fruit product cannot fail to be both abundant in quantity and high in quality. Its best general adaptation would seem to lie in the direction of pears, plums, apricots, and table grapes; less in that of peaches and almonds.

Nos. 928 and 930. Gravelly adobe soil and loam subsoil, from the ranch of the Messrs. Bancroft, on Walnut Creek, Ignacio Valley, Contra Costa County. The tract from which these soils were taken extends to Walnut Creek on the west, and near the banks of that stream shows a narrow band of very refractory, bluish-gray adobe, with lime concretions in its lower portion; it is some six to eight feet thick and rests on consolidated gravel beds, seen in the bed of the stream. To landward of the adobe band the soil still varies in bands running more or less parallel to the axis of the valley, being in general a blackish clay loam or light adobe, intermixed with more or less gravel and rock fragments derived from the head of the valley as well as from the flanks of Mt. Diablo. In places there are gravel ridges showing an almost sandy soil, and approaching these the normal blackish soil is underlaid by a brownish, rather silty subsoil, which farther away passes into a kind of brownish adobe clay, that with a further change of tint passes into the normal soil; which thus in places is found as much as three feet in thickness. It is then often underlaid by a well-packed gravel bed, which is, however, traversed by oak roots, and thus is doubtless also penetrable by those of fruit trees. The land is covered with a fine, moderately dense growth of large white oaks.

Of the analyses below, No. 928 represents the average blackish clay, or adobe soil of the Ignacio plain, while No. 930 exemplifies the brown subsoil, above referred to as occurring on the approach to the gravel ridges.

Soil and Subsoil of Bancroft Tract, Ignacio Valley.

	No. 928. Soil, 36 in.	No. 930. Subsoil, 12–20 in.
Coarse materials > 0.5mm	29.7	8.6
Fine earth	70.3	91.4
Analysis of Fine Earth.		
Insoluble matter	54.68 } 73.99	63.79 } 79.69
Soluble silica	10.31 }	15.90 }
Potash (K_2O)	1.01	.75
Soda (Na_2O)	.27	.25
Lime (CaO)	1.08	1.03
Magnesia (MgO)	1.82	1.55
Br. ox. of manganese (Mn_3O_4)	.06	.01
Peroxide of iron (Fe_2O_3)	4.25	3.50
Alumina (Al_2O_3)	11.20	9.92
Phosphoric acid (P_2O_5)	.10	.03
Sulphuric acid (SO_3)	.06	.06
Water and organic matter	5.55	3.37
Total	99.39	100.164
Humus	1.30	
Available inorganic	.55	
Available phosphoric acid	.06	
Hygroscopic moisture	9.07	7.00
Absorbed at 14° C.		

The analyses show in both the soil and subsoil an abundant supply of potash, and an ample one of lime. Phosphoric acid is in very good supply in the gravelly adobe, but quite deficient in the silty subsoil, showing good reason for the relative decrease of production toward the gravel ridges. But in the larger part of the tract, where the adobe is several feet in thickness, the dimensions of the old oaks speak of the quality of the soil, which is also manifest in the rapid development of fruit trees on adjacent farms. For plums and pears especially the soil and local climate seem admirably adapted. Considering that the sample analyzed (No. 928) represents three feet of soil, the percentage of humus found is very ample. But on the part of the land where No. 930 forms the soil, phosphate fertilizers will be in order.

MOUNTAIN VIEW SOILS.

No. 788.—Dark gravelly loam soil, from the place of Mr. J. S. Bunnell, two and a half miles southwest of Mountain View, Santa Clara County. Mr. Bunnell writes as follows regarding the land represented by this soil: "The land has a scattering growth of live and white oak; has been in wheat for years. From indications within half a mile or less there might have been chamisal (*Adenocarpos*) upon it once. The soil is easily worked, and might be called porous, for it does not hold water like adobe soil. Less than a quarter of mile northwest of it the red chamisal soil begins, which extends along the foot of the hills toward Searsville. A narrow strip of adobe touches my line a hundred feet or so. To the eastward we find in some places a great admixture of adobe, the section being much spotted. The place (of thirty acres) is within one fourth mile of the foothills of the Coast Range. As to the depth of the soil, I believe it does not change for at least seven feet, as ascertained in digging a neighboring cellar."

The soil is mouse-colored clay loam, intermixed with a good deal of

gravel; some of the latter quite coarse, and both rounded and angular, the rocks shown being part white and jaspery quartz, some hard black shale, and a considerable proportion of coarse conglomeratic sandstone, the latter mostly angular. These rocks indicate a derivation from the region northward of New Almaden, and from the hills immediately adjacent. The lumps of the dry soil can be crushed between the fingers with some difficulty, and on wetting become only moderately adhesive.

Nos. 971, 972.—A very similar soil, from the place of Mr. J. A. Sladky, within a short distance of Mr. Bunnell's land, was, with the subsoil, analyzed by Mr. M. E. Jaffa, of the viticultural department. The soil is very similar to the above, but a little less clayey; its depth is from two to three feet, when the color changes to a lighter and more reddish tint, while the clay is somewhat increased. There appears to be no change in the character of this subsoil for fifteen feet.

The analyses of these soils gave the following results:

Dark Gravelly Loam, Mountain View.

	No. 788.	No. 971.	
Coarse material and sand	53.5	50.0	
Fine earth	46.5	50.0	
Total	100.0	100.0	
	Soil.		Subsoil.
	No. 788.	No. 971.	No. 972.
Insoluble matter	57.45	62.27	60.10
Soluble silica	7.92	7.23	8.69
Potash	1.21	1.03	.90
Soda	*.82	.21	.28
Lime	3.52	2.70	2.96
Magnesia	2.89	2.99	4.33
Br. oxide of manganese	.11	.05	.06
Peroxide of iron	6.02	8.83	9.99
Alumina	12.31	7.13	8.16
Phosphoric acid	.19	.10	.10
Sulphuric acid	.04	.02	.02
Water and organic matter	8.25	7.29	4.63
Total	100.73	99.85	100.22
Humus	3.10	2.07	
Available inorganic	1.22	2.03	
Available phosphoric acid	.08		
Hygroscopic moisture	8.32	7.87	9.16
Absorbed at 15° C.			

*Determination doubtless too high.

These soils are specially interesting as representing the extreme western edge of the sloping, gently rolling plain that forms the western portion of the Santa Clara Valley southward of Mountain View. Along the streams the soil is of great depth, sometimes showing hardly a perceptible change for twelve or fifteen feet in depth, and the roots of trees are found penetrating freely to such depths in the gravelly material. This great depth, pervious-

ness, and perfect drainage would constitute, alone, no mean advantage, if the soil were only of moderate fertility. But the analyses show a very high supply of plant food, surprisingly so in view of the rather markedly low percentages found on the ranges near Searsville (see Bulletin No. 10, or Report of Agricultural College for 1884, p. 47). The dark, gravelly soil here in question is a very rich one in every respect. The potash and lime percentages are unusually high, as is also the supply of humus; that of phosphoric acid is high in No. 788, and nearly half of it is shown by the analysis to be in an available condition, notwithstanding the long cultivation in grain, which should have drawn heavily upon this ingredient. In No. 971 and in its subsoil this ingredient is in smaller but still very fair supply. Under the circumstances the large humus percentage is an earnest of a large supply of nitrogen also.

It is true that these large percentages apply only to one half of the soil mass, the rest being gravel. But the depth and easy permeability of the soil more than make up for the difference, in comparison *e. g.* with an adobe soil of similar composition.

These soils may be considered as well adapted to the production of almost any fruit consistent with the local climate, and should yield heavy-bodied, spirituous wines.

CUPERTINO VINEYARD SOILS.

The analyses given below of the soil and subsoil of the University vineyard plot on the land of Mr. John T. Doyle, Cupertino, are published in connection with the discussion of the grape production of that plot in Appendix No. 4, recording the work in the viticultural laboratory. Since, however, this appendix forms a separate publication which will not reach all of those interested in the present report, the analyses and discussion are reproduced here.

The land on which this tract is located forms part of the gently undulating valley slope that lies between the Santa Clara Valley proper and the Coast Range, and into the higher part of which Cupertino Creek and its branches have cut narrow and deep, abrupt valleys. The experimental plot assigned to the University lies immediately adjacent to the valley of the main Cupertino on the west and about fifty feet above it. The soil is a drab-tinted clay loam, largely intermixed with gravel and rock fragments, showing the whole to consist of the wash from the adjacent and other ranges lying toward New Almaden. In the bluff banks that fall off steeply into the creek bottom it can readily be seen that the same material, only with larger proportions of gravel, and yellow instead of a drab-colored loam, extends down nearly to the creek level. It is perfectly penetrable by both water and roots, the latter being seen in it at levels from twelve to even twenty feet below the trees and vines to which they belong. The land is therefore perfectly underdrained, and thus fulfills one essential condition of first class wine-grape land. It is, of course, easily workable soon after rains.

In order to obtain a full insight into the nature of the soil and subsoil, a trench six feet deep was dug in what might be considered a representative spot of the tract, and the soil material was sampled for each twelve inches from the surface, so as to obtain fair specimens. Three of these—viz.: 0 to 12 inches, 12 to 24 inches, and 5 to 6 feet—were fully analyzed chemically, as reported below; and as these analyses are sufficient to show both the general character and the rate and character of change downward, the samples representing the other intervals received only a physical examination. From about thirty to thirty-six inches below the surface

there is usually a noticeable change of tint toward the yellow, and an obvious increase of the gravelly ingredients, which is apparent in the wide difference in the percentage of "fine earth," in the table below, between the immediate subsoil twelve to twenty-four inches in depth and the sample taken from the interval thirty-six to forty-eight inches, the latter containing less than one fourth as much of soil matter proper than the former. But it is also seen that from thirty-six down to seventy-two inches the soil percentage remains almost the same, and judging from the aspect of the bank where the level land breaks off into the valley, the same might be true to the depth of ten or twelve feet, if not more.

Analyses of Soils and Subsoils from University Vineyard Plot, Cupertino.

	No. 986. Soil, 0 to 12 in.	No. 987. Subsoil, 12 to 24 in.	No. 989. Under Subsoil, 36 to 48 in.	No. 991. Under Subsoil, 60 to 72 in.
Coarse gravel			35.2	73.0
Fine gravel	30.3	37.5		
Sand			54.8	13.5
Fine earth	69.7	62.5	10.0	13.5
Totals	100.0	100.0	100.0	100.0
Analyses of Fine Earth.				
Insoluble matter	73.63	71.43		65.54
Soluble silica	6.25	7.98		9.74
Potash	.60	.63		.79
Soda	.03	.14		.03
Lime	1.44	1.59		1.29
Magnesia	1.36	1.53		1.88
Br. oxide of manganese	.02	.01		.01
Peroxide of iron	6.68	6.75		7.58
Alumina	5.43	5.72		8.58
Phosphoric acid	.10	.08		.11
Sulphuric acid	.01	.01		.01
Water and organic matter	4.30	3.96		4.65
Totals	69.84	99.82		100.22
Humus	.96			
Available inorganic	1.64			
Hygroscopic moisture Absorbed at 15° C.	5.14	5.13		8.05

It will be noted that notwithstanding the wide differences in the mechanical composition of the materials analyzed, they do not differ materially in the general composition of the fine earth, although there is a manifest increase downward of several of the ingredients. The potash supply is from good to high, the lowest material having one fourth more than the surface soil. The lime percentage is good in all, but decreases slightly in the lowest material, while the magnesia increases steadily downward. Phosphoric acid is practically, probably, the same throughout, and is in fair supply. Sulphuric acid is low throughout, and might advantageously be raised by the aid of plaster. Humus in the surface soil shows a fair percentage, perhaps as large as so pervious a soil will maintain in the local climate. The moisture absorption reaches a very satisfactory figure, and increases downward, parallel with a greater heaviness of the soil, as is shown by the increase of the item of alumina, the characteristic ingredient of clay.

Altogether the soil is a very fine one for vineyard purposes, both as to

its mechanical and chemical composition; and considering the great depth to which roots can readily penetrate it, it promises high durability. It is, moreover, so "generalized" in its character as to render the results obtained on it of wide applicability.

Compared with the two soils from the immediate neighborhood of Mountain View, described above, this soil is less calcareous and magnesian, and also somewhat lighter than the former, and comes nearer to the soil from Sladky's place than that from Bunnell's. It contains somewhat less potash, and about the same amount of phosphoric acid as the former. It is probable that soils similar to the others referred to exist, away from the wash of the Cupertino Cañon, at the foot of the hills to the westward of Mr. Doyle's vineyard.

No. 813. Under-subsoil, from near Montecito, Santa Barbara County; sent by Mr. H. C. Ford, President of the Santa Barbara Horticultural Society, for examination as to its probable quality as a subsoil for fruit trees. The sample was taken at the depth of four feet, and was penetrated by vigorous roots of an orange tree that had been killed by a gopher; and others growing around it in the same soil were in a flourishing condition. "The question with us all here is, can this subsoil furnish food for trees, and if so, in what manner can it be best fed to them?"

The sample sent consists of fragments of soft and easily broken sandstone, mingled with a friable mass resulting from the disintegration of the rock. In such a mass high percentages of plant food cannot be looked for; the question is only whether it is totally barren, as is often the case, or may be considered as contributing in any material degree to the nourishment of the trees. The fact mentioned in the letter, that the roots found were covered with small ones penetrating fissures, points to the actual nourishment of the roots by the rock.

This supposition is fully borne out by the analysis, which resulted as follows:

Sandstone Under-Subsoil.

Coarse sand	1.6
Fine earth	98.4
Insoluble residue	81.83
Potash	.41
Soda	.31
Lime	.33
Iron and alumina	12.38
Phosphoric acid	.03

As a surface soil such a material would, on account of the low percentage of phosphoric acid, be accounted but of moderate promise and in imminent need of having its phosphates supplemented by fertilization. As the surface soil of the region is, however, known to be well provided in this respect, and it is the higher roots that chiefly supply the mineral food to the tree, a subsoil like this lying at four feet depth, and containing fair supplies of potash and lime, is a good deal better than many found elsewhere in corresponding positions. It is not, however, a marl; and the best mode of utilizing it is to leave it just where it is, to be extracted by the roots of fruit trees and vines.

No. 865. Gray loam soil, from ranch of Mrs. A. C. W. Truesdell, five miles from San Buenaventura. This soil was sent with the statement that "the land is planted to cherries, which will not bear. They are black Tartarian, eight years old, grow well, blossom profusely, and seem healthy

in every respect. Have plenty of iron spikes driven into them by the former owners. The fruit sets abundantly, but when the size of a pea it falls off, having turned yellow and leathery in the skin, and is found entirely empty, no stone having formed ever so small or soft. Cherries grow very well in cañons five miles from here. I am five miles from the sea, and almost every kind of fruit grows abundantly."

The soil is a mouse-colored loam, its lumps easily crushed between the fingers when dry, and becomes but very slightly plastic when wet. It is certainly not too heavy for cherries. On the supposition that the failure to form seed might be due to a deficiency of phosphoric acid, the amount of the latter was determined and found to be abundantly large, the percentage being .192, unusually high. Probably the fault does not lie in the composition of the soil, but in other conditions, which can only be ascertained by observation on the spot.

E. Northern Coast Range.

No. 866. Marsh soil from near Sonoma Landing, Sonoma County. Sent for examination by Mr. A. J. Henderson, of Stockton. This sample was taken from the general surface of the marsh, rejecting the vegetable mass above it, which lost by ignition 32.75 per cent. It is a bluish gray, rather silty mass, with a good deal of vegetable matter visibly scattered through it; on leaching, it yielded to water .176 per cent of soluble mineral salts. The solution, while indicating the presence of a little carbonate of soda, consisted in the main of the sulphates, with a small amount of the chlorides, of magnesium and sodium. As the sulphates are only sparingly present in sea water, it appears that here, as well as on the islands of the San Joaquin delta previously examined (see report for 1877, p. 45; 1879, p. 35), there has been a partial removal of the common salt and bittern that constitute the characteristic ingredients of sea water. The analysis of the unleached soil gave the following result:

MARSH SOIL FROM SONOMA LANDING.

Coarse materials > 0.5mm	
Fine earth	
	All.
Analysis of Fine Earth.	
Insoluble matter	36.52 } 67.04
Soluble silica	30.52 }
Potash (K_2O)	1.14
Soda (Na_2O)	.50
Lime (CaO)	1.07
Magnesia (MgO)	2.11
Br. ox. of manganese (Mn_3O_4)	.10
Peroxide of iron (Fe_2O_3)	5.27
Alumina (Al_2O_3)	15.97
Phosphoric acid (P_2O_5)	.08
Sulphuric acid (SO_3)	.03
Water and organic matter	6.15
Total	99.52

This soil is certainly eminently worthy of reclamation. It is rich in potash and lime, and contains a fair average proportion of phosphoric acid. The soluble salts it contains are neither in quantity nor quality enough to interfere in any serious degree with the cultivation of such crops as are suitable for land in such a location. With deep and thorough cultivation there need be no trouble from "alkali."

Soils and subsoils from Edgehill Vineyard, Mr. William Scheffler's, near St. Helena, Napa County. This well known place is located, as its name implies, on the spurs of the range bordering Napa Valley, on the west. This range is of very complex structure, and its rocks are so disposed that a relatively slight change in position parallel to the range, may make a very serious difference in the nature of the soil, which may, according to circumstances, be derived either from a gray clay shale, a calcareous sandstone, or the tufaceous rock of eruptive origin that forms the crest of the range. According as the ravines cut lightly or deeply into the hills, the alluvium they deposit may be totally different in character, varying from a heavy adobe clay to a light sandy or silty soil. It would require a detailed survey to outline the areas covered by the several different soils, and at least a dozen analyses to represent all the variations.

A set of thirty-two samples of soils and subsoils, representing half that number of localities on the property, was carefully taken by Mr. N. E. Rose, the superintendent. It was not easy to select from these representative samples, and those of which the analyses are here given serve rather to show the extreme diversity of land than to give an accurate idea of the prevalent features.

No. 833. Sandy hill land. A whitish-gray, light soil, which has been under cultivation for six years. Vines grow in it slowly, but otherwise do well. At twelve inches depth the color changes to a creamy white, the subsoil being white-pulverulent with numerous lumps of a whitish, very soft, decomposed sandstone. It is this subsoil that has been analyzed.

No. 838. Hill soil, virgin; plowed first in 1884. A purplish-red loam, quite friable when in lump, with little clay, but a great deal of angular gravel and rock fragments. The rock becomes more abundant in the subsoil, and the substance of the latter (at eight to sixteen inches) is a very heavy clay of a tawny-yellow tint with whitish dots—sandstone fragments. The soil only analyzed.

No. 842. A blackish-gray or mouse-colored loam, easily crushed when dry, with very coarse grains of sand and angular gravel; shows very little clay when wetted and kneaded; virgin soil. Its subsoil, from ten to sixteen inches, is a tawny-colored semi-adobe, mingled with a great many rock fragments, mostly sandstone. Soil only analyzed.

SOIL FROM MR. SCHEFFLER'S VINEYARD.

	No. 833. Subsoil, 8–16 in.	No. 838. Soil, 6 in.	No. 842. Soil, 6 in.
Coarse materials > 0.5mm	66.0	33.0	7.6
Fine earth	34.0	67.0	92.4
Analysis of Fine Earth.			
Insoluble matter	85.52	54.73	70.49
Soluble silica	4.39 } 89.91	9.18 } 63.92	5.02 } 75.51
Potash (K_2O)	.22	1.37	1.39
Soda (Na_2O)	.55	.19	.30
Lime (CaO)	.23	2.40	.71
Magnesia (MgO)	.17	1.93	1.68
Br. ox. of manganese (Mn_3O_4)	.06	.20	.10
Peroxide of iron (Fe_2O_3)	1.09	6.62	3.03
Alumina (Al_2O_3)	5.11	16.77	9.84
Phosphoric acid (P_2O_5)	.04	.05	.04
Sulphuric acid (SO_3)		.13	.38
Water and organic matter	3.10	6.286	7.64
Total	100.48	99.87	100.62
Humus		1.15	2.34
Available inorganic		.48	.50
Hygroscopic moisture	3.43	8.05	6.18
Absorbed at 13.5°C.			

The soil contains free sulphur in considerable quantity.

The sandstone soil (No. 833) shows in the composition of its subsoil good cause for the slow growth of vines. Its potash percentage is barely above deficiency; that of lime is low; phosphoric acid very low, and in presence of so little lime, doubtless not in a very available state. High percentages of plant food are not to be expected in a soil having ninety per cent of inert matter, but in most such cases great penetrability and depth make up to some, or sometimes to the full extent, for such deficiencies. Whether this is the case in this soil, I have not the data to determine. If not, it is simply a poor soil, requiring complete fertilization for thriftiness.

No. 838. This singular looking soil, having more the aspect of "mineral paint," contrasts strongly with the former one. It has abundant supplies of both potash and lime, and a fair one of humus. Its phosphoric acid percentage is, however, quite low, and its production would doubtless be very much stimulated by the use of phosphate fertilizers. At eight inches depth, however, it is underlaid by a heavy clay subsoil, which has not been analyzed, and of which it can only be said that it must be very difficult of drainage in wet seasons. It is not often that so great a difference in soil and subsoil is found.

No. 842. The dark loam soil is in aspect the most promising of all, and analysis sustains the impression on all but one point, viz.: phosphoric acid, in which it falls slightly below the preceding. It differs from the latter in having somewhat less lime and more humus, but its potash percentage is extraordinary even in California, and will not easily be exhausted even by cropping with vines. Its subsoil is much less refractory in its nature than that of No. 838. It is a tawny-tinted semi-adobe, largely mingled with rock fragments, but apparently readily penetrable by both water and roots.

So far as the evidence goes, it points strongly to the need of applying phosphate fertilizers to all these soils whenever their production languishes.

Upland soil, from the south slope of a hill in Conn Valley, two miles east of St. Helena, from the ranch of Perry & Walther, sent by Dr. A. W. Perry, San Francisco. Taken from a hole twelve by twelve inches. A grayish, gravelly loam, said to grow grapes very well.

Coarse material > 2mm		25.66
Coarse material from 2mm to 6mm		18.25
Fine earth		56.09
Analysis of Fine Earth.		
Insoluble matter	68.03	80.17
Soluble silica	12.14	
Potash (K_2O)		.60
Soda (Na_2O)		.22
Lime (CaO)		1.22
Magnesia (MgO)		1.39
Br. ox. of manganese (Mn_3O_4)		.05
Peroxide of iron (Fe_2O_3)		3.25
Alumina (Al_2O_3)		8.63
Phosphoric acid (P_2O_5)		.05
Sulphuric acid (SO_3)		.003
Carbonic acid (CO_2)		
Water and organic matter		4.48
Total		100.063
Humus		1.32
Available inorganic		.60
Available phosphoric acid		.05
Hygroscopic moisture		4.50
Absorbed at 16.5° C.		

This soil has a good supply of potash, lime, and humus, and although that of phosphoric acid is rather low, it appears all to be in an available form, and thus, for the present, adequate. With this composition, its light, gravelly nature, and considerable depth, it will doubtless prove a good soil for grapes.

Vineyard soils from Mr. J. H. Drummond's place, Glen Ellen, Sonoma County. Mr. Drummond's vineyard lies near the mouth of Nun's Cañon, a deep and narrow valley cut into the range separating Napa and Sonoma Valleys; and apparently the three soils sampled by Mr. Drummond are representatives of a considerable belt of foothill land lying along the base of the range on the Sonoma side. The visible rocks of the region are partly ferruginous shales or shaly sandstones, evidently composed in part of the debris of volcanic tufas or breccias, which themselves mostly form the country rock; their exact relation to the shales it is not easy to observe. While in the central and higher parts of the range the soils are inclined to be heavy and clayey, as exemplified in soil No. 799, heretofore examined (see Bulletin No. 24, or report for 1884, p. 52), and of a gray tint, those of the foothills on the Sonoma side are often of a glaring orange red, and in texture rather light loams. On the lower slopes the color is less intense, and in the undulating lands forming the eastern valley slope near Nun's Cañon, the color is modified into a "sienna" brown tint, becoming a deep chocolate brown when wet. The latter class of lands, represented by No. 802 below, is heavier than the foothill lands proper, and dry clods cannot

be crushed between the fingers, while this can easily be done with the red hill soils. All contain a certain proportion of gravel, or rock fragments more or less rounded, though not as abundantly as in the Napa Valley near Oakville and Rutherford.

The following table gives the results of the analysis of the two chief varieties just referred to:

No. 805. "Hill soil taken about one hundred feet above the valley to the depth of one foot; southern exposure. Land formerly thickly covered with black oak trees and poison oak; also a little fern. Many bowlders were taken from this hill." This soil, a glaring red loam, is underlaid at the depth of from twelve to thirty inches by similar material, gradually becoming a little lighter tinted and more clayey. Below this pebbles are found, or at times a subsoil of decomposed tufaceous rock is reached at varying depths, while sometimes the latter crops itself out on the surface.

No. 802. "A sienna brown, rather clayey loam, from the valley slope or lower vineyard, where the newly imported grape varieties (Cabernet Sauvignon, etc.,) were grown." No perceptible change of nature or tint to three feet, the substratum below that depth gradually becoming more reddish and lighter in texture, beyond the depth of four feet.

VINEYARD SOILS, GLEN ELLEN.

	No. 805. Hill Soil.	No. 802. Valley Soil.
Coarse material	11.0	12.7
Fine earth	89.0	87.3
Analysis of Fine Earth.		
Insoluble matter	40.33	59.26
Soluble silica	15.19	9.33
Potash	.45	.32
Soda	.38	.36
Lime	.53	.65
Magnesia	.33	.44
Br. oxide of manganese	.09	.10
Peroxide of iron	9.15	5.85
Alumina	24.60	16.45
Phosphoric acid	.03	.09
Sulphuric acid	.08	.09
Water and organic matter	9.00	7.59
Total	100.19	99.53
Humus	1.65	1.78
Total available inorganic	.52	.49
Available phosphoric acid	.04	.05
Hygroscopic moisture	11.44	8.28
Absorbed at	15.5° C.; 15° C.	

A general feature of interest shown in these analyses is that in these soils, as in nearly all others thus far examined from districts where volcanic rocks prevail, there is a large proportion of dissolved silica and of soda, indicating the presence of a large amount of easily decomposable silicates, in which doubtless the greater part of the potash, soda, and perhaps lime, shown in the table, are concerned, since water dissolves no sodium compounds (alkali) from the soils. The same indication is given

by the extraordinary quantity of alumina dissolved in the analysis out of soils showing only a moderate amount of clay. While therefore the potash percentages of both soils are not as high as is usual in the Napa Valley, yet what there is can doubtless be made currently available by the use of lime, and thus supply the demands of grape culture for a long time after the soils have fallen off from their natural yield. As regards phosphates, the supply in the valley soil is very fair, and that of the hill soil above deficiency; but the determination of the "available phosphoric acid" shows that very unusually high proportions of the total supply of both are in an available condition. In No. 805 two thirds, and in No. 802 over one half. For present purposes, therefore, this important substance may be considered as being in full supply in both soils. Both, also, have a good supply of humus—unexpectedly so in the hill soil, whose high retentiveness of moisture is, however, obviously due to the large proportion of iron.

Considering their origin, depth, "lay," and physical as well as chemical nature, these soils are certainly best adapted to the fruit culture to which they are now being mainly devoted, which utilizes the depths as well as the surface of the land, and (especially in the case of the vine and olive) draws but lightly upon the soil's resources in the commercial products, whose high quality will compensate for a relatively lower production. Comparison with the soils previously examined, from the west side of the valley, on Hooper's place (see report for 1882, p. 48), seem to show that there both the valley and hill soils are richer in phosphoric acid as well as in lime, owing, doubtless, to their partial derivation from the marly rocks of the territory. Glen Ellen, therefore, would appear adapted to the production of the relatively lighter and more highly-flavored wines.

No. 894. Subsoil from the rolling country west from Cloverdale, Sonoma County. This sample was sent by Mr. J. H. Whitman, of San Francisco, and is stated to be, with its corresponding surface soil, a fair representative of the uplands of the region, said to vary but little in character from ridge to ridge. It bears the usual growth of manzanita and oaks that is so common in the Coast Range north of the bay country.

The soil is a somewhat clayey loam of a reddish orange tint, darkening to a reddish brown when wetted. It is stiffish, but crumbles between the fingers when pressed; contains a considerable admixture of gravel, some of which is as much as three fourths of an inch in diameter, part being rounded, part angular, and consists mostly of reddish quartzite with some decomposed sandstone. When kneaded the so wet soil becomes quite plastic, but shows a large proportion of coarse sand, which should make it work easily under the plow. The soil shows no sensible change down to eighteen and sometimes to as much as fifty inches. The sample analyzed was taken to the depth of twelve inches.

Soil near Cloverdale.

	No. 894. Soil, 20 in.
Coarse gravel > 0.2mm	42.0
Coarse sand > 0.5mm	16.0
Fine earth	42.0
Analysis of Fine Earth.	
Insoluble matter	33.33 } 57.61
Soluble silica	24.28 }
Potash (K_2O)	1.50
Soda (Na_2O)	.26
Lime (CaO)	3.40
Magnesia (MgO)	1.85
Br. ox. of manganese (Mn_3O_4)	.15
Peroxide of iron (Fe_2O_3)	5.49
Alumina (Al_2O_3)	18.83
Phosphoric acid (P_2O_5)	.15
Sulphuric acid (SO_3)	.07
Carbonic acid (CO_2)	
Water and organic matter	10.47
Total	99.78
Humus	2.83
Available inorganic	.77
Available phosphoric acid	.06
Hygroscopic moisture	6.86
Absorbed at 15° C.	

It will be noted that 58 per cent of this soil consists of gravel and coarse sand; but the composition of the 42 per cent of fine earth is sufficiently promising to make up amply for that circumstance. With the extraordinary amounts of one and a half per cent of potash, over three of lime, and nearly three of humus, and one and a half tenths of phosphoric acid, this soil is about as well equipped for productiveness and durability as could be desired; the more as nearly half of the phosphoric acid is in the available form. Wherever it is sufficiently deep it should do well with almost any crop adapted to the climate and to uplands in general; but, all things considered, fruit would probably be its specialty.

Nos. 959 and 964. Upland soils from Elder Creek, Tehama County, sent by Huntington, Hopkins & Co., Sacramento. Regarding the localities from which these soils are derived, the following data are given: "The land is located from ten to twelve miles west of the town of Tehama, on both sides of Elder Creek. The formation of the land on Township 25 is known as bald adobe hills, with a very deep, rich soil, especially adapted to raising wheat. The character of the soil changes toward the east into what is known as 'hogwallow' plains, ascending (descending?) towards the Sacramento River, and also descending on either side towards Elder Creek. The surface of the land resembles the hogwallow plains in Sacramento County (covered with small mounds), but lies more on an incline. The surface is almost destitute of vegetation, has not been tilled to any extent, and what has been done has had very unsatisfactory results. Some parties claim that the bedrock comes too close to the surface; at all events the land has not produced anything save in an unusually wet season. The object of the inquiry is, to determine what the land could be profitably used for, and whether, in case it were attempted to raise fruit, it would be necessary to blast out the bedrock, as is being done in Sacramento County.

The expense of leveling this land for cultivation would probably exceed its present value."

The six samples sent represent apparently two chief types—one, No. 959, a gray, sandy soil, mixed with a large proportion of gravel; the other a high-colored red soil (No. 964), also very sandy and gravelly, but containing enough of clay to render the land "almost impassable when wet. The bedrock is eighteen to thirty-six inches from the surface. It is nearly barren as far as natural vegetation goes. In a well dug to a depth of one hundred and seventy to two hundred feet in this land, the soil taken out is all very similar to that at the surface, excepting here and there a layer of bedrock or gravel." This land is designated as "high rolling hogwallow." The area occupied by the gray soil is described as "low table land running back to high bald (adobe) hills; soil a very leachy, coarse gravelly sand—a very light crop of wheat growing on it."

Reference is also made to a tract of "high, rolling land; soil, sand and light adobe, with a heavy growth of squaw grass." The samples representing this tract could unfortunately not be identified from the notes.

The following table shows the result of the analyses:

UPLAND SOILS FROM ELDER CREEK.

	No. 959. Gray Soil.		No. 964. Red Soil.	
Coarse materials >0.5mm	60.5		57.7	
Fine earth	39.5		42.3	
Analysis of Fine Earth.				
Insoluble matter	73.86	79.16	74.62	81.04
Soluble silica	5.30		6.43	
Potash (K_2O)	0.53		0.17	
Soda (Na_2O)	0.25		0.24	
Lime (CaO)	1.27		1.56	
Magnesia (MgO)	1.86		0.79	
Br. ox. of manganese (Mn_3O_4)	0.07		0.02	
Peroxide of iron (Fe_2O_3)	3.48		3.41	
Alumina (Al_2O_3)	8.72		8.98	
Phosphoric acid (P_2O_5)	0.07		0.04	
Sulphuric acid (SO_3)	0.11		0.07	
Carbonic acid (CO_2)				
Water and organic matter	4.28		3.56	
Total	99.80		99.89	
Humus	0.83		0.57	
Available inorganic	0.50		0.84	
Available phosphoric acid			0.02	
Hygroscopic moisture	3.50		4.57	
Absorbed at 13° C.; 16.5° C.				

There is a wide difference between these two soils as to the most essential ingredients of plant food. The gray soil, No. 959, though very gravelly, is of good composition in its fine earth, showing a fair supply of potash and phosphoric acid, a very full one of lime, and even a fair one of humus. With sufficient depth it should do well for field crops, and for fruits, such as cherries, peaches, and almonds; for the moisture absorption of 4.2 per cent shows it to be not nearly as "leachy" as are some good fruit soils in Southern California. If it does not produce well it must be because the "bedrock" is too near the surface. What material that rock may be, the samples and description do not give the means of determining. Probably

it is simply a hardpan requiring to be broken up, once for all, in order to give passage to the roots.

No. 964, the red soil, is far below the other in its resources, being deficient in potash, and its phosphoric acid very low, though largely in an available form. As, in addition, the bedrock is stated to be often near the surface, its reclamation does not seem to offer much inducement at the present time. Hereafter it may be found available for vines, almonds, olives, etc., after breaking the hardpan.

Considering its great variety of soils of extreme properties, this district should have a fuller investigation.

II. ANALYSES OF WATERS.

A. Artesian Waters.

Artesian water from a well forty-three feet deep, on the land of Mr. P. C. Phelps, of Upper Lake, Lake County. The locality is three and one half miles north of Clear Lake, in the valley. "In boring this well the first ten feet showed gravel and sediment, the remaining thirty-three feet blue clay with tule roots. The flow of water is at the rate of one hundred and twenty-five gallons per hour, together with a great deal of gas, which will burn with a blue flame (marsh gas) through a pipe four and one half inches in diameter. There is a cover on the pipe twenty inches above the spout, and the stream of water takes up one half of the spout."

The water proves to be saturated with carbonic acid gas, which of course also accompanies the combustible gas. It is clear and without perceptible taste. On boiling it becomes turbid; on evaporation it leaves a white residue amounting to 11.6 grains per gallon, which on heating loses 3.3 grains of water with a little organic matter. Of the remaining 3.8 grains only one grain is again soluble in water, while 7.3 remain insoluble.

The soluble part consists in the main of sodium chloride or common salt, with a little carbonate of soda.

The insoluble part, constituting the main bulk of the mineral contents, consists essentially of the carbonates of lime and magnesia in about equal proportions, with a little iron and silica.

The mineral contents of this water are quite within the limits of good potable waters, and the nature of the ingredients is equally unobjectionable in the proportions found. It is well adapted to domestic use, and its hardness in the use of soap can easily be remedied by the addition of a little washing ammonia. The carbonic gas imparts a refreshing taste.

Water from the artesian well at the Stockton Asylum for the Insane. It will be remembered that the analysis of what was supposed to be this water was reported in a previous bulletin (No. 20). It has since appeared that the water then analyzed was from another well (Salmon's), supposed to be of the same character, but much stronger in salts than the asylum well. A sample of the latter has since been sent by Mr. W. M. Fitzhugh, Assistant State Engineer; and while the ingredients of the water were found to be nearly the same in kind as those of the former water, they are very much less in quantity. The data stand as follows:

	Grains per Gallon.
Total solid contents	36.6
Again soluble after evaporation	25.4
Insoluble after evaporation	6.5
Organic matter and water	4.7

As the water of Salmon's well contains 209 grains of salts, it will be noted that the difference in favor of the asylum well water is very considerable, although the amount of salts present is still too great for many purposes.

1. *Water from a bored well*, five miles west of Fresno City, at the vineyard of Dr. John Hastings. The proprietor states in regard to this well, that it is one hundred and five feet in depth, the water rising within twelve feet of the surface. The supply is so large that a steam pump, with a three-inch suction pipe, cannot sensibly reduce the water. The water is clear and tasteless, though evidently hard. It is slightly alkaline when fresh. The solid contents amount to 22.3 grains per gallon. Of the residue there is:

	Grains per Gallon.
Again soluble in water	7.1
Insoluble	9.1
Volatile (water and organic matter)	6.1

The soluble part is still slightly alkaline, and consists in the main of the sulphate and chloride of sodium, or Glauber's and common salts, with some gypsum (sulphate of lime), and small amounts of the sulphate of potash and magnesia; a trace of carbonate of soda. The insoluble part consists chiefly of carbonate of magnesia, with some carbonate of lime and silica. This water is well adapted to irrigation, since so large a proportion of its solid contents consists of lime and magnesia. For domestic use its hardness can be abated by boiling, or by the use of about one tenth of its bulk of lime water, when most of the lime and magnesia will be thrown down as a white sediment. It is similar in this respect to the waters of the Mission San José, described in a previous bulletin (No. 20), save in so far as it contains more magnesia instead of lime, and might in the course of time affect persons having weak digestion.

Former examinations made on the spot have shown that all well waters near Fresno contain a large amount of lime, with some magnesia, which are deposited on boiling. Thus, at the Central Colony, at Mr. T. C. White's, *a sample of the crust deposited in a boiler* by the water on his place, near Fresno, was sent by Mr. B. Marks. The deposit, which was hard and almost glassy looking, proved to be composed, in about equal proportions, of the carbonates of lime and magnesia. It stands probably, therefore, in the same category as Mr. White's; both can be deprived of their excess of earthy ingredients, for domestic purposes, by the use of lime water. The latter can be readily kept on hand in a barrel, into which a handful of lime has been thrown. After filling with water and stirring, the water will in a short time become clear again, and can then be mixed with the well water which it is desired to soften, in such proportions as may be found adequate. This proportion usually varies between one to eight and one to

fifteen, and can readily be ascertained by any one, by trying successively larger measures of lime water, until the well water does not show any more turbidity on the addition of more lime water, after allowing it to settle. The incrusting of kettles can thus be prevented, and delicate stomachs that resent the presence of magnesia, relieved.

Artesian water from a well four hundred and forty-two feet deep, bored near Lemoore, Tulare County, by Mr. E. Jacob, of Visalia. The water is slightly yellowish, but clear; is strongly alkaline to test-paper.

	Grains per Gallon.
Total residue by evaporation	26.75
Again soluble	21.49
Carbonate of soda	19.30
Insoluble	.87
Water and organic matter	4.38

The soluble part is intensely alkaline. It contains chiefly carbonate of soda, with a little common and Glauber's salt, and considerable potash. The yellowish tint is due to vegetable matter dissolved by the soda, as is shown in the blackening of the evaporation residue when heated.

This water is quite similar in composition to one previously examined from the same region. (See report for 1884, page 62.) Where it is used for irrigation the soil must be regularly supplied with plaster to neutralize the carbonate of soda. Most persons will use it for drinking purposes with impunity.

Artesian water; sent by Mr. Daniel Rhoads, Lemoore, Tulare County. The water was taken from a well nine hundred feet deep. It is quite decidedly alkaline, from carbonate of soda, requiring about one tenth of lime water for precipitation.

	Grains per Gallon.
Total solid contents	26.98
Again soluble after evaporation	23.01
Insoluble after evaporation	.76
Organic matter and water	3.21

The soluble part is exceedingly alkaline, consisting largely of carbonate of soda and a small amount of chloride of sodium, or common salt. The insoluble part, which is very small, is carbonate of lime and a small amount of silica.

The large proportion of carbonate of soda in this water, as well as in other wells in this region, indicates the need of the use of plaster on the land when these waters are used for irrigation. For most persons its use for drinking purposes would be unobjectionable.

Water from an artesian well on the land of J. H. Hoskins, south of Lake Tulare; sent by Dr. S. F. Chapin, of San José. The depth and exact location of this well are not given. The water is clear and tasteless.

Angeles. The water is clear, and shows only a faintly alkaline taste. On

TABLE I.

Analyses of California Soils and Subsoils.

No.	Soil Title.	Locality.	County.	Depth in Inches.	Vegetation.	Insoluble Residue	Silica, Soluble in Na_2CO_3	Total Insoluble Residue and Silica	Potash	Soda	Lime	Magnesia	Brown Oxide of Manganese	Ferric Oxide	Alumina	Phosphoric Acid	Sulphuric Acid	Carbonic Acid	Water and Organic Matter	Total	Humus	Available Inorganic	Available Phosphoric Acid	Hygroscopic Moisture	Temperature of Absorption(°)	Analyst.
	A. Great Valley.																									
858	Redland soil	Florin	Sacramento	4–48	Oaks and grass	82.94	6.28	89.21	.28	.07	.60	.23	.09	1.91	5.42	.02	.01	....	2.26	100.10	.46		.02	2.6	14°	Morse.
949	Adobe subsoil			3–12 thick		72.07	7.51	79.58	.38	.16	.52	.64	.02	5.10	9.41	.05	.01	....	4.12	100.02				7.7	14°	Colby.
950	Bedrock hardpan			1–10 ft. thick		72.65	6.12	78.77	.43	.14	.61	.95	.02	5.65	9.31	.08	.01	....	4.08	100.05				8.7	14°	Colby.
891	Fawn-colored alluvial soil	Tulare Lake border	Kern	12	Alkali grass, weeds	54.71	9.84	64.55	2.02	2.73	2.46	2.93	.03	7.46	11.50	.11	.04	1.81	1.34	99.90				10.5	10°	Colby.
893	Light bluish-gray clay soil	Tulare Lake border	Kern	12		56.92	10.73	67.65	1.65	.54	2.96	3.12	.04	6.73	10.35	.16	.01	.93	5.77	99.92	.38	1.01		8.6	10°	Colby.
77	Lake sediment	Tulare Lake border	Kern	12		67.34	....	....	1.05	.84	6.51	3.69	.01	5.05	7.97	.32	.08	4.12	3.71	101.29	.17	2.18		....	....	Morse.
	B. Sierra Foothills.																									
976	Soil	Colfax	Placer	0–6	Pine, black oak, manzanita, and tar-weed	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2.10	.58	.024	....	....	Morse.
977	Subsoil	Colfax	Placer	6–21		67.69	8.05	75.74	.49	.14	.25	.53	.18	3.85	13.32	.05	.03	....	5.41	99.99				6.0	16°	Morse.
861	Light loam soil	Grass Valley	Nevada	0–10	Yellow and sugar pine; white, live, and scrub oak; manzanita and chaparral	43.81	11.37	55.18	.16	.17	1.29	2.19	.03	8.25	21.87	.03	.10	....	11.16	100.43	2.37	.71	.020	8.2	17°	Morse.
863	Soil	Grass Valley	Nevada	12	Spruce, cedar, fir, pine, and some black oak	23.93	10.95	37.91	.15	.21	.33	.30	.07	8.25	35.38	.09	.07	....	16.48	100.24	2.89	.76	.016	11.2	17°	Morse.
	C. Southern Region.																									
809	Subsoil (lighter)	Riverside	San Bernardino	12	Alfilerilla, bunch grass, lupins and wild flowers	78.36	5.62	83.88	.79	.56	1.51	1.24	.28	3.70	6.68	.11	.05	....	1.06	100.46	12	.31		2.6	41°	Morse.
812	Subsoil (heavier)	Riverside	San Bernardino	12		68.34	7.10	75.44	.97	.31	1.05	1.68	.04	3.64	10.19	.05	.01	....	2.11	99.96	.19	.39		5.5	14°	Morse.
	D. Southern Coast Range.																									
912	Surface soil	Piedmont	Alameda	12	Large white oaks	78.43	5.79	84.22	.58	.19	.72	.56	.19	2.21	6.07	.05	.02	....	5.54	100.35	2.48	.88	.05	4.7	15°	Morse.
882	Valley soil	Pacheco Valley	Contra Costa	12	Bunch and squirrel grass	63.28	8.84	72.12	.77	.57	1.49	2.35	.17	1.91	12.86	.06	.01	....	5.03	100.55	4.07	.90	.06	9.1	15°	Morse.
928	Dark adobe loam	Ignacio Valley	Contra Costa	0–36	Large white oaks, bunch grass	54.68	19.31	73.99	1.01	.27	1.08	1.82	.06	4.25	11.20	.10	.03	....	5.55	99.38	4.30	.55	.06	9.1	14°	Morse.
930	Subsoil	Ignacio Valley	Contra Costa	12–20		63.79	15.90	79.70	.75	.25	1.03	1.55	.01	3.50	9.92	.03	.06	....	3.37	100.46				7.0	14°	Morse.
788	Mouse-colored clay loam	Mountain View	Santa Clara	12	Live, white oak and chamisal	57.15	7.92	65.37	1.21	.82	3.52	2.89	.11	6.02	12.31	.19	.04	....	8.25	100.73	3.10	1.22	.08	8.3	15°	Morse.
971	Dark gravelly loam	Mountain View	Santa Clara	12	Live and white oaks; much poison oak.	62.27	7.23	69.50	1.03	.21	2.70	2.99	.05	8.83	7.13	.10	.02	....	7.29	99.85	2.07	2.03		7.9	15°	Jaffa.
972	Subsoil	Mountain View	Santa Clara	12		60.10	8.69	68.79	.90	.28	2.96	4.33	.05	9.99	8.16	.10	.02	....	4.63	100.22				9.2	15°	Jaffa.
986	Soil	University Vineyard, Cupertino	Santa Clara	0–12	Live and white oaks, poison oak, some chamisal	73.03	6.25	79.88	.60	.03	1.44	1.36	.02	6.68	5.43	.10	.01	....	1.30	99.84	.96	1.61	.03	5.1	15°	Colby.
987	Subsoil	University Vineyard, Cupertino	Santa Clara	12–24		77.13	7.98	79.41	.63	.04	1.59	1.53	.01	6.75	5.72	.08	.01	....	3.56	99.82				5.4	15°	Colby.
991	Under subsoil	University Vineyard, Cupertino	Santa Clara	60–72		65.54	9.74	75.28	.79	.03	1.29	1.88	.01	7.58	8.58	.11	.01	....	1.65	100.22				8.1	15°	Colby.
	E. Northern Coast Range.																									
866	Marsh soil	Sonoma Landing	Sonoma	....	Large tule	36.52	30.52	67.04	1.14	.49	1.07	2.11	.10	5.27	15.97	.08	.09	....	6.15	99.50	....	....	....	....	....	Morse.
833	Yellowish-white subsoil	Scheffler's Vineyard, near St. Helena	Napa	12	Small oaks, pines	85.53	4.40	89.92	.22	.55	.23	.47	.06	1.09	5.11	.04	....	....	3.10	100.49	....	....	....	3.43	13.5°	Morse.
838	Purplish-gray loam	Scheffler's Vineyard, near St. Helena	Napa	2–6	Oaks, manzanita, chaparral	54.73	0.18	63.91	1.37	.19	2.40	1.93	.20	6.62	16.77	.05	.13	....	6.29	99.86	....	47	....	8.4	13.5°	Morse.
842	Blackish-gray loam	Scheffler's Vineyard, near St. Helena	Napa	2–6		70.49	5.02	75.51	1.40	.30	.71	1.68	.10	3.03	9.84	.04	.37	....	7.64	100.02	2.33	50	....	6.2	13.5°	Morse.
805	Hill soil	Glen Ellen	Sonoma	12	Black and poison oak and ferns	40.33	15.19	55.52	.45	.38	.53	.33	.09	9.15	21.60	.06	.08	....	9.00	100.49	1.65	52	.01	11.4	15.5°	Morse.
802	Valley soil	Glen Ellen	Sonoma	12	Large oaks	59.26	9.33	68.59	.32	.36	.65	.44	.10	5.85	16.45	.09	.09	....	7.59	99.63	1.78	49	.05	8.2	15.5°	Morse.
1005	Upland soil	Conn Valley	Napa	0–12	Not stated	68.03	12.14	80.17	.60	.22	1.22	1.39	.05	3.25	8.63	.05	.01	....	4.48	100.06	1.32	60	.05	4.5	16.5°	Morse.
894	Reddish-brown subsoil	Cloverdale	Sonoma	18	Oaks, madroue, manzanita	33.33	21.28	57.61	1.50	.26	3.10	1.85	.15	5.49	18.83	.15	.07	....	10.47	99.78	2.83	.77	.06	6.8	15°	Morse.
959	Gray sandy upland soil	Elder Creek	Tehama	Several feet.	Nearly barren; wild flowers	73.85	5.30	79.16	.53	.25	1.27	1.86	.07	3.48	8.72	.07	.11	....	4.28	99.81	.83	.50		3.5	13°	Morse.
964	Upland soil	Elder Creek	Tehama	18–36 in. thick.		74.02	6.43	81.04	.16	.24	1.56	.79	.02	3.41	8.98	.04	.06	....	3.56	99.88	.56	.84	.02	1.6	13°	Morse.

	Grains per Gallon.
Total solid contents	7.8
Again soluble after evaporation	5.0
Insoluble after evaporation	1.2
Water and organic matter	1.6

The soluble part consists of a mixture of chloride, sulphate, and carbonate of soda, the latter least in amount.

The insoluble part consists in the main of carbonate of lime, with a little magnesia and silica.

The mineral contents of this well water are remarkably low, especially if, as is presumable, located near Tulare Lake. It resembles more nearly a river than a well water of the region, and may be considered well suited to all purposes, whether irrigation or domestic use.

This case seems to confirm the presumption raised in other cases, that excellent artesian water can be obtained in the Tulare region, provided that the influx of the alkaline waters from higher levels be completely excluded by tight tubing.

Water from an artesian well, located on S. 33, T. 25, R. 23, Kern County, about fifteen miles southwest of Delano Station; sent by Mr. Geo. A. Raymond, of San Francisco. This well is three hundred and forty feet deep, bore eight inches in diameter, and has an estimated flow of one million five hundred thousand gallons per twenty-four hours.

The water when fresh is colorless and tasteless, very faintly alkaline to test-paper.

	Grains per Gallon.
Total residue after evaporation	10.16
Again soluble in water	5.02
Insoluble in water	2.08
Organic matter and combined water	2.45

On heating, the residue blackens considerably and gives off an acid odor.

The soluble part consists in the main of sulphate of soda or Glauber's salt, with some common salt and a little carbonate of soda.

The insoluble part consists in the main of carbonate, with a little sulphate of lime, and little or no magnesia.

It thus appears that the permanently soluble matters in this water exist in usually small proportions for an artesian water, and do not greatly exceed in amount those occurring in Kern River, while less objectionable in quality; there being very little carbonate of soda. This large volume of water may therefore be considered suitable for all practical purposes—irrigation as well as domestic use; and considering its location in a region noted for the extensive prevalence of salts near the surface, this result is both unexpected and important, as it encourages the hope that similarly pure streams may be reached by the auger at other points in the neighborhood.

Well water, from a bored well of the West Side Water Company, at Los Angeles. The water is clear, and shows only a faintly flattish taste. On

evaporation deposits silky needles of gypsum, together with some carbonates of lime and magnesia.

	Grains per Gallon.
Total solid contents	34.77
Again soluble in 50 per cent alcohol	8.59
Insoluble in same	20.86
Organic matter and combined water	5.32

The portion soluble in alcohol consists in the main of sulphate of soda, or Glauber's salt, together with common salt. The portion insoluble in the same is gypsum, with some carbonates of lime and magnesia, and a little silica.

The predominant and characteristic ingredient of this water is gypsum, which constitutes the bulk of the 20.86 grains per gallon, and would be likely to interfere somewhat with the use of the water for domestic purposes.

B. Common Well Waters.

Well water, sent by General J. Bidwell, Chico. "The well is fifty feet deep. Top soil, five feet of sandy loam, then hard, red, gravelly clay forty feet, then five feet into fine gravel of lighter color. Plenty of water, and cold; cased with iron pipe for twenty feet from the surface."

The water is very turbid, and does not clear with fifteen minutes' boiling; clears upon boiling one hour.

The water is slightly alkaline; its residue blackens upon ignition, and leaves considerable unburned organic matter.

	Grains per Gallon.
Total residue by evaporation	7.58
Again soluble	2.22
Insoluble	3.88
Water and organic matter	1.48

The soluble part is quite strongly alkaline, showing the presence of carbonate of soda; the latter, dissolving the organic matter of the deposits through which it passes, causes the blackening of the evaporation residue when heated; but such matter is not injurious. Besides the soda carbonate, some Glauber's salt and common salt are present. The insoluble part consists mainly of carbonate of lime, with some magnesia and silica. Altogether, the water is a very pure one.

The water of shallower wells on General Bidwell's place is much less pure, the solid contents rising as high as eighteen grains per gallon, with magnesian salts in the soluble part.

Well water, sent by Mrs. E. D. Murray, Auburn, to determine its fitness for domestic purposes. At the time of its analysis, some three months after it was received, it had a very disagreeable odor, and had evidently undergone fermentation. It is only faintly alkaline to test-paper.

	Grains per Gallon.
Total solid contents	10.60
Again soluble after evaporation	1.60
Insoluble after evaporation	5.61
Organic matter and combined water	3.39

The soluble part consisted of alkaline carbonates, and chloride of sodium in small quantity; while the insoluble part was largely carbonates of lime and magnesia, small amount of sulphate of lime, and considerable silica.

It was found almost impossible to ignite the residue completely, even after extraction of soluble salts. This points to the presence of albuminous nitrogenous matter, which would indicate sewer contamination. The quantity of chlorides, however, is quite small for impurities from this source. The microscope shows a large number of minute animalculæ in the residue of the water, and gives further evidence of the doubtful character of such a water for domestic use.

Well water, sent by Mr. C. W. Reed, Sacramento. The water is very faintly alkaline.

	Grains per Gallon.
Total solid contents	12.32
Again soluble after evaporation	.76
Insoluble after evaporation	8.88
Organic matter and combined water	2.68

The soluble part is quite decidedly alkaline, and contains, besides the carbonate, considerable chloride and sulphate of sodium. The insoluble part consists largely of carbonate of lime, with considerable carbonate of magnesia, and small amounts of sulphate of lime and silica.

The mineral matter in this water is unobjectionable, both in amount and in kind.

Well water, sent by Mr. W. S. Leber, Santa Rosa, September, 1885. "The water and sediment come from a well situated eight miles west of Santa Rosa, and three and one half miles north of Sebastopol, among the hills. The well is dug at the foot of a little bluff, on rather low ground, and is twenty-two feet deep. The surface soil is gray sand, then comes a yellow, sandy clay, then this black sediment through which the water oozes up. There is no vein of water, and it maintains a depth of about two and one half feet. The well was dug about three months ago, and the water is colored from a redwood planking underneath the brick wall. If the water is not all drawn out occasionally, it creates a most disagreeable smell."

The filtered water remains turbid; is slightly alkaline.

	Grains per Gallon.
Total solid contents	10.51
Again soluble after evaporation	2.86
Insoluble after evaporation	5.08
Organic matter and combined water	2.57

The soluble part is faintly alkaline to test-paper, and consists chiefly of chloride of sodium, together with small amounts of sulphate and carbonate. The insoluble part carries considerable iron and alumina, a plentiful supply of lime, a slight amount of magnesia, and small quantity of silica.

No injurious effects would come from the small amount of salts contained in the water.

A very heavy sandy sediment, carrying with it a little clay, lime, and free sulphur, settled from the water, and was similar in composition to the sample of dry material accompanying the water, collected near the well and supposed to have come from the same source.

The disagreeable odor which comes from the water upon standing is due to the formation of sulphydric acid formed from the free sulphur and organic matter in the deposits. The redwood casing undoubtedly increases the disagreeable taste in the water.

Water from a well at the Napa Asylum for the Insane, sent by Dr. L. F. Dozier. This is a dug well, of no great depth; has been used for some time, and it has been suggested that it might be contaminated with sewage. The water is clear and tasteless; rather hard. On evaporation it left a residue amounting to 16 grains per gallon, of which 9.9 grains was again soluble, and 6.1 grains insoluble. The latter part consists in the main of the carbonates of lime and magnesia, with a little gypsum. The soluble part consists prevalently of chloride of sodium, or common salt; also, a little of Glauber's salt or sulphate of soda, and chloride of magnesium or bittern.

A close examination showed the absence of nitrates, ammonia salts, or of any objectionable kind or proportion of organic matter. The saline ingredients of the well are simply derived from tide water in Napa Slough, and are not present in excessive proportions.

Well water, sent by Mr. Amos Bailey, Pacheco. The water turns turbid on boiling, or by exposure to air.

The sender notes that "scum rises upon the water," and wishes to know "whether vegetables will be injured by it."

On evaporation it gave:

	Grains per Gallon.
Total residue	117.7
Again soluble after ignition	51.3
Insoluble after ignition	43.2
Organic matter and water	23.2

The soluble part consists chiefly of the sulphates and chlorides of sodium, or Glauber's and common salt, with a little gypsum and Epsom salt.

The insoluble part is a mixture of much gypsum with the carbonates of lime and magnesia, and a little silica.

This water, with its fifty-one grains per gallon of salts of sodium salts, cannot be permanently used for the irrigation of any vegetable, as the salts would accumulate in the soil, and stunt or kill all vegetation. It is, of course, unfit for domestic use.

Well water, from the ranch of Messrs. Bancroft, Ignacio Valley, Contra Costa County. From a well eighty feet deep, near the house; the water

tastes somewhat flattish; on boiling, deposits heavy crusts in kettles. The fresh water is rather strongly alkaline, but upon evaporation the soluble part is neutral, and consists in the main of common salt. By far the larger part of the thirty-four grains of solid contents in this water is carbonates of lime and magnesia, the latter quite abundant, so that the daily use of the raw water is likely to induce derangement of digestion. It can readily be reduced to a small percentage of mineral salts by adding to it one seventh of its bulk of lime water, and allowing the white precipitate to settle overnight.

The waters of this region are very similar to those of Mission San José, described in report for 1884, page 59.

Well water, sent by Mr. G. W. Wilson, San José.

	Grains per Gallon.
Total solid residue	23.48
Organic matter and loss	5.70

The water is quite alkaline with sodic carbonate. It contains no sulphates, but a notable proportion of sodium chloride, or common salt, in its soluble portion. The insoluble part is, as usual in the Santa Clara Valley, chiefly carbonate of lime with a little magnesia.

Well water, sent by Mr. C. Fowler, San Miguel, San Luis Obispo County, from well ninety feet deep. Water somewhat alkaline.

	Grains per Gallon.
Total residue	20.79
Again soluble	2.45
Insoluble	10.52
Organic matter and loss	7.82

The soluble part is somewhat alkaline from carbonate of soda, but consists in the main of common salt.

The insoluble part consists largely of carbonate of lime, considerable magnesia, and a little silica.

This water is rather strongly calcareous, and could be improved for domestic use either by boiling or by the addition of about one tenth of lime water and subsidence of the white precipitate thrown down.

Well water, sent by Mr. J. W. Pew, 310 Pine Street, San Francisco. It was taken from a driven well, ninety-two feet deep, on a block adjoining the northwest corner of Eisen vineyard, near Fresno. A sample of fine dust, which separates from the water, accompanies the water sample.

	Grains per Gallon.
Total residue	15.53
Again soluble	2.16
Insoluble	7.47
Organic matter and loss	5.90

The water is clear and colorless, but distinctly alkaline. The soluble part consists almost wholly of common salt, with a little carbonate of soda.

The insoluble part consists of the carbonates of lime and magnesia, with a little iron and silica.

The water is a good one for domestic use, the vegetable matter held in solution by the carbonate of soda being unobjectionable in quality.

Well water from a well five miles north of San Buenaventura, Ventura County. The sender desires to know how to make the water "take soap."

The water is clear at first, but upon boiling becomes very turbid from the separation of the carbonates of lime and magnesia, and silica. Upon evaporation the water gave:

	Grains per Gallon.
Total solid contents	160.86
Again soluble after ignition	110.40
Insoluble after ignition	33.64
Organic matter and water	16.82

From the above results it appears that only a generous use of sal-soda can make the water take soap, after the white sediment has settled. The soluble part consists of the sulphates and chlorides of sodium, calcium, and magnesium; and considering this fact, it is somewhat remarkable that the water has actually been used for drinking, despite the Epsom salt.

Water from a surface well near Hueneme, Ventura County; sent by E. O. Gerberding, with the following information: "The water tastes well, but my neighbors say that such water is highly injurious, not only to plants watered with it, but also to the land. I am just starting a berry patch, and need water to irrigate; the well is close by and contains sufficient water for my purpose, but I am afraid to use it until I hear from you. To get artesian water would require an outlay of some $350, which I naturally desire to avoid."

The water is clear but has a somewhat flattish taste, and is very hard.

	Grains per Gallon.
Total solid contents	68.3
Again soluble after evaporation	29.4
Insoluble after evaporation	29.6
Organic matter and combined water	6.3

The soluble part consists of the chlorides and sulphates of soda, lime, and magnesia, the former predominating. The insoluble part consists of the carbonates of lime and magnesia, with some gypsum and silica.

The latter portion would not be objectionable so far as the land is concerned; but nearly thirty grains of saline ingredients to the gallon is more than can safely be used on any soils but those that can be well drained from time to time, so as to wash out the soluble "alkali" salts. The water is not strong enough to injure plants *directly*, but only through the accumulation of the alkali by repeated use and evaporation from the surface. When this can be avoided, even such waters as those of Tulare

Lake are available; and many worse waters are used in India with the proper precautions.

Water from a well in the Highland Park Tract, three miles from Los Angeles Post Office; sent by Mr. William Inglis, of that place. This well is seventy feet deep. After passing through six feet of adobe, the auger showed all the rest of the way a sandy gravel, in which the seven-inch piping was finally stopped.

The water, when fresh, has a strong odor of sulphuretted hydrogen. On expelling this gas the water has still a sulphurous taste, proving it to contain an alkaline sulphide in very appreciable quantity.

	Grains per Gallon.
Total solid residue after evaporation	73.7
Again soluble	64.4
Insoluble	9.3

The soluble portion has a strongly alkaline reaction, and contains chiefly sulphate of soda, or Glauber's salt, with carbonate of soda and common salt; also, when fresh, some hydrosulphide of sodium.

The insoluble part consists of a mixture of the carbonates of lime and magnesia.

While this water is far too strongly mineral for either domestic use or irrigation under ordinary circumstances, it is likely to prove valuable for curative purposes, if the supply should be found adequate, and deserves a closer examination than it is within the province of the station to bestow.

Well water, sent by Mr. L. F. Gay, of Los Angeles: "This well is situated in the northeast part of the city, not over one hundred yards from the Los Angeles River, on the Hunter tract—not artesian, but water raised by windmill. We reached a flow of water in about twenty feet, but the water was salty in flavor. We went on down about fifty-five feet, where there seemed to be sulphur in the water along with the salty flavor. Well is now to bedrock, about seventy-four feet deep; about fifty feet of water in the well. Where the water runs out of a brass faucet there has gathered a good deal of green material, like green rust. Well is piped by a seven-inch iron pipe, and perforated only in the lower link, as the entire distance was through sand and light gravel, the last foot near the bedrock being large gravel, stones, and bowlders. We desire to know whether the water is suitable for household purposes, for stock, and irrigation."

The analysis gave the following result:

	Grains per Gallon.
Total residue (ignited)	177.9
Again soluble	144.1
Insoluble	33.8

The soluble part is quite strongly alkaline, and consists of carbonate and chloride of sodium, or "soda" and common salt.

The insoluble part consists mainly of the carbonates of lime and magnesia, the former predominating; with some iron oxide and alumina, probably originally dissolved in carbonic acid.

This water is far too strong in mineral salts for any domestic or agricultural purpose, except, perhaps, the watering of cattle; nor can its mineral contents be materially decreased by any cheaply practicable process.

C. Spring Waters.

Water from Hot Springs, at Agua Rica, Sonoma County; sent by Captain H. E. Boyes, Sonoma. The temperature of this spring is said to range from 98° to 100° F., and from experience had is supposed to possess other qualities that would render it valuable as a bathing resort for invalids. The water is clear and slightly alkaline to test-paper; taste, slightly flattish.

	Grains per Gallon.
Total solid contents	53.21
Again soluble after evaporation	39.13
Remaining insoluble	10.22
Organic matter and combined water	3.86

Qualitative analysis shows the soluble portion to be quite strongly alkaline; it is composed mainly of sodium chloride, or common salt, with small amounts of sulphate and carbonate of soda.

The insoluble portion consists about half and half of silica on the one hand, and the carbonate of lime and magnesia with a little gypsum on the other.

The mineral constituents of the water, while too high for domestic use, characterize it as a slightly alkaline, saline water; and as, in addition, it carries a certain proportion of magnesia carbonate, it will doubtless find curative use both internally and externally.

Water from Walter Soda Springs, Napa County; sent by Mr. Gust. Walter, of San Francisco. This water as received was slightly turbid, and showed a sediment of rust-colored floccules, showing its "chalybeate" character. Carbonic acid gas escapes abundantly when the bottle is opened.

On boiling, the water becomes quite turbid, and shows by its alkaline reaction the presence of some carbonate of soda.

On evaporation it leaves a residue of 143.8 grains of solid matter, which by heating to redness loses 58.0 grains of water and a little organic matter, leaving 85.8 grains of pure mineral matter. Of this there is:

	Grains per Gallon.
Again soluble	32.8
Insoluble	53.0

The soluble part consists largely of chloride of sodium or common salt, with smaller amounts of the carbonate and sulphate of soda.

The insoluble part consists largely of carbonate of magnesia, with some carbonate of lime and silica. The fresh water contains, in addition, as above stated, some iron in the shape of carbonate. All these are kept in

solution by the free carbonic acid which renders the water effervescent and refreshing to the taste.

This is, therefore, a mineral water of moderate strength, of tonic and at the same time slightly purgative qualities, the drinking of which doubtless would be advantageous in many chronic diseases.

Spring water, sent by Mr. L. A. Raleigh, Corralitos, Santa Cruz County. Supposed to have mineral properties. The water is clear, tasteless, and odorless.

	Grains per Gallon.
Total solid residue	12.73
Again soluble	2.33
Insoluble	6.89
Organic matter and water	3.50

The soluble part consists mainly of common salt, with small amounts of potash, lime, and magnesia; no sulphates.

The insoluble part, forming the bulk of the solid ingredients, consists of some gypsum, the carbonates of lime and magnesia, and silica.

The water is not remarkable, either in the quantity or quality of its ingredients, and is a fair water for domestic use.

Hot spring waters, sent by Mr. J. Kelleher, Monterey. They were taken from hot springs situated about twenty-three miles from Monterey, at Pico Blanco.

	No. 1.	No. 2.	No. 3.	No. 4. (1)	No. 4. (2)
Total solid contents, grains per gallon	18.4	22.31	23.30	18.28	22.83
Again soluble after evaporation, grains per gallon		13.26	16.89	11.85	11.03
Insoluble after evaporation, grains per gallon		6.08	4.51	4.21	2.98
Organic matter and water, grains per gallon		2.97	1.86	2.22	8.82

No. 1, when taken, had a temperature of 90° F. It has no smell of sulphur.

No. 2, when taken, had a temperature of 120° F.; is quite strongly alkaline, and has a decided taste of sulphuretted hydrogen. The alkalinity continues strong in the soluble portion after evaporation. Besides carbonate of soda, there is an abundance of sodium, chloride, and sulphate. The insoluble part is composed of lime, magnesia, and silica.

No. 3, temperature 112° F.; smells strongly of sulphuretted hydrogen, and is not alkaline, although the soluble part becomes strongly so. This water also contains, in the soluble part, an abundance of carbonate of soda, small amount of chloride of sodium, and a slight amount of sulphate of soda. Only a small amount of lime and magnesia make up the insoluble part.

Two samples of water, marked No. 4, temperature 112° F., quite different in all respects, were analyzed.

No. 4 (1) has no indication of sulphur, is quite alkaline, becomes strongly so in the soluble part, shows the presence of abundant supply of carbonate of soda. The soluble part after evaporation contains, in addition to the carbonate of soda, a large amount of chloride and sulphate of

soda, and a slight amount of magnesia. The insoluble part is largely silica.

No. 4 (2). This water tastes and smells very strongly of sulphuretted hydrogen; is not alkaline at first, although the soluble part becomes very strongly so after evaporation. During the ignition the residue becomes black. The soluble part consists mainly of carbonate of soda, with small amounts of chloride and sulphate, only a trace of magnesia. Lime, magnesia, and silica make up the small amount of insoluble residue.

Spring water, sent by Mr. Horace Whitaker, Visalia. The water was taken from a spring on Mrs. Turner's place, thirty miles north of Visalia. "Supposed to be unfit for family use; considerable sickness in the family using the water."

The water is slightly alkaline; the residue blackens slightly upon ignition.

	Grains per Gallon.
Total solid contents	18.22
Again soluble after evaporation	8.29
Insoluble after evaporation	7.01
Organic matter and water	2.92

The total amount of mineral matter in this water is somewhat large, but not excessive nor noxious. The soluble part consists essentially of common salt and Glauber's salt. The insoluble part is mainly lime carbonate, with a little magnesia and silica. The water is thus a strongly calcareous one, but does not show in its composition any cause for ill health to those who use it, although at first it might create disturbance with persons unused to it.

Mineral water, sent by Mr. John Barker, Sumner, Kern County; from a spring which "flows from under the mesa into Kern River, some six miles east of Sumner Station. Temperature, 80°."

The water smells strongly of sulphuretted hydrogen when the bottle is first opened, but the odor soon disappears upon standing open. The water is very alkaline.

	Grains per Gallon.
Total residue	208.2
Again soluble	187.8
Insoluble	10.8
Organic matter and loss	9.6

The soluble part consists mainly of common salt, with carbonate and sulphate of soda and some sulphate of potash; on evaporation salt crystals separate plentifully.

The insoluble part consists of the carbonates of lime and magnesia, with a little iron oxide and alumina.

A saline alkaline water of considerable strength.

Waters from Arrowhead Hot Springs, near San Bernardino; sent by Messrs. Darby & Lyman, the proprietors. There are four springs, of which those mentioned below are the chief.

Spring No. 1—The water is slightly alkaline when fresh; is clear and colorless.

	Grains per Gallon.
Total solid contents	70.9
Again soluble after evaporation	53.0
Insoluble after evaporation	12.2
Organic matter and combined water	5.7

The soluble part consists chiefly of sulphate of soda, or Glauber's salt, with common salt or chloride of sodium, a little gypsum or sulphate of lime, and a very small amount of carbonate of soda. The insoluble part consists chiefly of silica, with small amounts of the carbonates of lime and magnesia.

Spring No. 2—General appearance and properties of water the same as in No. 1.

	Grains per Gallon.
Total solid contents	66.0
Again soluble after evaporation	53.2
Insoluble after evaporation	9.3
Organic matter and combined water	3.5

In kind the ingredients of this water do not seem to differ materially from those of No. 1.

From this composition it appears that both waters are light purgatives, of moderate strength. The high temperature of these springs, and the sulphuretted hydrogen which several of them carry in addition to the saline ingredients (but which had not been preserved in the specimens examined), of course add materially to the medicinal effects.

Drainage water, from the sewage farm of the Stockton Asylum for the Insane; sent by Mr. William M. Fitzhugh, Assistant State Engineer, with the following remarks: "The sewage of the institution is used to irrigate a field or farm, and this field is underdrained by tile laid five to seven feet deep. It is proposed to serve an injunction upon the asylum against discharging this water, which has percolated through the soil for five feet, from being discharged into the canal, although every one in that vicinity discharges sewage pipes directly into the same canal. You will readily see the object of the examination which Dr. Brown requests you to make of the water."

The water is faintly yellowish but otherwise clear. On evaporation it yields 45.6 grains of solid residue, of which 7 grains is organic matter and water volatile on ignition. The ignited residue is quite alkaline from the presence of carbonate of soda. To the dissolution of vegetable matter by this salt the yellowish tint is due, but the amount of such matter is quite small. The saline residue consists in the main of common salt with some Glauber's salt and carbonate of soda.

The examination shows the composition of this water to be nearly the same as that of many artesian waters, and not widely different from that of the asylum well itself. Its organic matter is such as it would naturally

take from the soil in its passage, or possibly retain from the sewage; but it does not putrefy on standing, and evidently has been amply purified in its filtration through the soil for discharge into any channel not serving for the supply of drinking water. In the present case no reasonable objection can lie against it.

III.—ANALYSES OF ROCKS, MARLS, FERTILIZERS, ETC.

1. *Calcareous sandstone*, with impressions and fragments of large shells; from the Coast Range, near San Mateo.

This rock, which contributes largely to the formation of soils west and south of San Mateo, was found to contain 3.43 per cent of lime, equivalent to 6.12 of calcic carbonate. This is too little to entitle it to consideration as a fertilizer or marlstone, but it shows it to be a very desirable contributor to the soils of the region.

2 and 3. *Marlstones*, from the Coast Range off Woodland, Yolo County; sent by Mr. N. Wyckoff, of Woodland. The samples were taken at points nine miles apart.

No. 2 is a soft, sandy limestone, of coarse texture, rather soft.

No. 3 is similar, but even more coarse-grained and less pure. Both are of a yellowish-white tint.

	No. 2.	No. 3.
Residue insoluble in dilute acid	8.7	30.84
Carbonate of lime	------	58.10
Phosphoric acid	------	.04

So far as they can be readily obtained in the pulverized condition, these rocks are available as calcareous marls; but it does not appear that they would supply anything besides lime to the soils, and lime is, generally speaking, abundant in the valley soils of Yolo.

4. *Limestone (Marlstone);* sent by Mr. R. R. Kirkpatrick, San Miguel, Santa Barbara County, in order to learn its possible uses. The analysis resulted as follows:

	Per Cent.
Insoluble residue	7.70
Carbonate of lime	85.25
Carbonate of magnesia	3.87
Iron oxide and alumina	1.80
Moisture and loss	1.38
	100.00

This shows the rock to be available for the burning of lime for ordinary purposes, agricultural and otherwise. It would possess some hydraulic properties, and from this cause, as well as on account of its color, would hardly be available for plastering.

5. *Marlstone;* sent by Mr. C. F. Stamps, Orange, Los Angeles County. A yellowish, friable rock, which analysis showed to contain 33.3 per cent of carbonate of lime. It might, therefore, be useful as a marl on soils requiring lime.

6. *Another sample*, sent at the same time, proved to be crystallized *Gypsum* imbedded in a clayey material. As gypsum is much needed as a fertilizer in that region, if found in sufficient quantity, the deposit would be valuable.

7. "*Bedrock*," sent by Mr. C. D. Brooks, Diamond Springs, through Mr. C. H. Dwinelle. "The material is hard when first uncovered, but disintegrates on exposure, so that in a few years a considerable furrow can be turned with a plow. Said to be an excellent fertilizer for trees, and if sown upon wheat it sometimes makes the crop too rank. It occurs at a depth varying from a few inches to several feet. Soil above it usually light brown and ashy, as though formed from it. Occurs in patches alternating with red soil over slate. Fruit trees and vines generally do well on both soils, with irrigation."

A decayed, talcose eruptive rock or tufa, of a smooth, magnesian touch. Whitish, with ferruginous layers.

Analysis showed it to contain only 0.070 per cent of phosphoric acid—hardly enough to account for any fertilizing effects.

8. *Calcareous tufa*, sent by Mr. G. W. Merk, Guerneville, Sonoma County. Supposed to be available for making hydraulic cement.

Sample No. 2.—A yellowish-white, porous, but quite hard rock. Its partial analysis gave:

	Per Cent.
Carbonate of lime	91.18
Carbonate of magnesia	4.41
Insoluble residue	1.61
Moisture	.44

This rock proves to be too nearly a pure limestone to be available for cement. It is evidently formed by calcareous water (of which a sample was also sent) trickling down ravines and hillsides, as so commonly happens in the Santa Cruz Range.

9. *Calcareous tufa*, sent by Mr. E. Parker, 57 Nevada Block, San Francisco. "A large body of this outcrops on my land about twenty-five yards below a large spring, in the Santa Cruz Mountains, about fifteen hundred feet above Santa Cruz Valley."

It is a soft tufaceous material, easily pulverized between the fingers. It contains 1.48 per cent of material insoluble in dilute acetic acid. The portion dissolved is carbonate of lime, with a little magnesia. The rock would answer well for lime-burning, or as a marl.

10. *Tartar waste*, from the refining of argols. Obtained by Mr. C. H. Dwinelle from Mr. A. Haas, San Francisco, to determine its value as a potash fertilizer.

On ignition it gave (calculated on the air-dried substance):

	Per Cent.
Ash	35.25
Organic matter and loss	64.75

The ash contains:

Soluble part	37.71, or 13.29 per cent of the total.
Insoluble part	62.29, or 21.96 per cent of the total.

The soluble part is but slightly alkaline.

Potash forms 7.49 per cent of the ash, or 2.64 per cent of the total tartar waste.

11. The following analyses of a number of *commercial alkalies*, offered in the San Francisco market as ingredients for tree washes, were made with a view to determine their relative values for the purpose. Most of these were published in Bulletin No. 52 of the College of Agriculture, given in Appendix No. 4 of the present report, which see for a discussion of the subject:

Composition of Commercial Alkalies.

1. "Philadelphia solid lye," sent by R. Wheeler, Fresno.
2. American concentrated lye, from San Francisco agencies.
3. Double concentrated, ninety-eight per cent caustic soda, from Greenbank Alkali Works Company, St. Helens, Lancashire, England. T. W. Jackson, agent in San Francisco.
4. Refined pearlashes; same manufacturer.
5. Commercial potash, Langley & Michaels, San Francisco.
6. Canadian crude potashes; commercial.
7. Eureka lye, M. Ehrman & Co., manufacturers, San Francisco.

	1.	2.	3.	4.	5.	6.	7.
Caustic soda	22.7	80.4	99.3				91.0
Caustic potash					52.3		
Carbonate of potash				69.1	16.8	71.4	
Chloride of potassium						3.6	
Chloride of sodium	66.6	5.9			4.9		5.6
Carbonate of soda						2.3	
Sulphate of soda		13.2			14.8		4.2
Sulphate of potash					7.5	14.4	
Silica					0.1		
Insoluble residue					2.1	2.7	
Moisture	6.4	0.5		23.8	1.5	4.5	

No. 6 gives the usual composition of Canadian crude potashes, as found in commerce, and may be taken as representing that of the lye of wood ashes when boiled down. It is the material from which No. 5, the "commercial caustic potash," is made by treatment of lime.

The relative practical value of these several materials for the purpose of tree-spraying, as well as for most others, is accurately gauged by the percentage of caustic alkali (soda, or potash,) which they contain.

IV. EXAMINATIONS OF VEGETABLE PRODUCTS, FRUITS, ETC.

Examination of Syrups from the Alvarado Sugar Factory.

The interest attaching to the improvement in the production of sugar from beets, devised and patented by Mr. Edward F. Dyer, the manager of the Alvarado factory, rendered it desirable to determine by actual analysis the changes which the syrups undergo in the process. As noted in a recent publication (Overland Monthly for December, 1886, page 561), this improvement nearly does away with the output of molasses as a by-product, with a net gain of nearly two per cent in the output of white sugar. This is effected by returning to the tanks in which the fresh juice is being defecated, the syrup that has dripped from the raw sugar, after first subjecting it to what is known as the Dubrunfaut diffusion process. This consists in placing the raw syrup into flat square bags of parchment paper that are suspended in slowly flowing water. An exchange takes place between the two liquids through the pores of the parchment paper; the water passes *in*, diluting the syrup, but at the same time a portion of the syrup, and with it a notable proportion of the salts contained in it and which would greatly interfere with a subsequent use of the syrup for sugar making, pass *out* from the bags and are taken away by the water. After the syrup has thus been reduced to about half its former density, the process is interrupted, and the purified and diluted syrup is transferred to the "defecating tanks" to be treated together with fresh juice, while the parchment diffusers are refilled with fresh syrup. According to the ordinary presumption, the salts remaining in the syrup that has undergone the diffusion process would thus gradually accumulate and vitiate the production of sugar from the juice; but the record of daily assays during the campaigns of three years show that the average purity of the syrups has not decreased to any noticeable extent.

The object of the investigations made during the present season has been to determine what becomes of the salts contained in the raw syrup *before* diffusion and remaining in it *after* the process; which of them pass out into the flowing water, and how the remnant in the diffused syrup is disposed of in the defecating vats. The investigation is, however, one requiring more time than has been at command in our laboratory this season, and hence only two points have been determiued thus far, to wit: the amount and kind of salts in the syrups before and after the process. The composition of the water outside, and that of the refuse from the defecation tanks, have only been partially examined; and for the accurate comparison and understanding of the several processes, we lack some data which can only be gathered on the spot; such as, *e. g.*, the relative quantities of the outside diffusion water, and of the diffused syrup, and the kinds and amounts of sugars in each. The sugars in these products are so easily decomposible that they cannot be accurately studied even the day after the samples were taken, much less under the conditions under which the laboratory work at the University is of necessity performed. It is hoped that with an increased working force, the points left unsettled may be investigated next season.

Tabular View of the Changes Produced in Raw Beet Syrup by Passing Through the Dubrunfaut "Osmogenes" at the Alvarado Factory.

	Before Passing Through the Osmogenes.	After Passing Through the Osmogenes.
Specific gravity of syrup	1.309	1.132
Ash percentage of syrup	5.12	1.81
Sugar percentage of syrup	56.90	29.02
Total solids of syrup	62.02	30.83
Water of syrup	37.98	69.17
Ratio of ash to sugars	1:11.11	1:16.03
Sugars and Salts in 100 of Dry Substance:		
Sugars	91.75	94.13*
Total ash	8.25	6.21
Soluble salts of ash	7.41	5.11
Insoluble salts of ash	.85	1.10
The soluble and insoluble portions of the ash contain:		
Soluble part:		
Sodium chloride	2.02	.85
Sodium carbonate	.37	.63
Potassium sulphate	.42	.47
Potassium carbonate	4.60	3.16
Totals	7.41	5.11
Insoluble part:		
Carbonate of lime	.51	.51
Carbonate of magnesia	.28	.54
Iron oxide, alumina, and silica	.06	.06
Totals	.85	1.10
The composition of the water outside of the osmogenes has not as yet been fully investigated. The data obtained so far are the following:		
Specific gravity		1.040
Ash		2.55
Sugars, etc.		8.15
Total solids		10.70

*This figure is probably a little too high.

The proportion of this outside water to the outgoing syrup from inside the osmogenes being unknown, its relation to the latter can not be fully traced. Roughly speaking, the specific gravities and solid contents of the three fluids show the ratio to stand about thus: The bulk of the raw syrup entering the osmogenes has been approximately doubled when the diffused syrup leaves the apparatus, and the water serving for the diffusion contains only one third as much total solids as the syrups after treatment, or about six times less than the original syrup entering the osmogenes.

Leaving out of consideration the mineral contents of the creek water (Alameda Creek), which probably do not exceed twenty grains per gallon, the gain in the removal of salts from the syrup is perhaps best shown in the following statements of ratios of salts to sugars in the three fluids:

	Salts.	Sugars.
Raw syrup	1	11
Diffused syrup	1	16
Outside water	1	3.2

The fact that the salts pass out more rapidly than the sugars through the osmogene membrane, is thus very clearly shown; but the total amount

of solids shown in the outside water is so large that a more liberal flow through the tank would seem likely to yield even better results than are now obtained, since the decrease of salts in the diffused syrup is relatively slight.

The changes that occur in the saline contents of the syrup during the process are shown in the above table to be these: The total ash is diminished by about one fourth; this decrease takes place almost wholly in the permanently soluble (alkaline) salt, while the earthy salts show a slight (doubtless relative) increase.

Among the alkaline salts the decrease tells chiefly on the sodium chloride and potassium carbonate, of which the former is reduced to less than half, while the latter loses over one fourth. Thus the total decrease of the alkaline solids is not quite one third of their total amount.

Under this showing it becomes of additional interest to know what becomes of the rest of these salts after their transfer to the defecating tank. If eliminated in the defecating process they must be found in the lime scum or refuse that form the by-product of defecation. An analysis of this material was given in a former report, but as no accumulation of alkaline salts in this refuse was suspected they were not sought for. A sample sent from Alvarado at the same time as the syrups and from a tank to which the diffused syrups had been returned, was examined for its alkaline salts, with the result given below—the statement being a combination of the former analysis with the present determination:

Potash (K_2O)	.16
Soda (Na_2O)	.57
Ammonia ($N H_3$)	.67
Phosphoric acid (P_2O_5)	1.57

The rest being a mixture of lime, partly hydrated, partly carbonated, with various organic matters and water. The amount of alkalies shown in the above determination is hardly large enough to account for the failure of the salts to accumulate during the campaign, and it is curious to note that the soda is taken out in the defecation-slum more abundantly than the potash, being the reverse of what might have been expected. Since, as the table shows, the potash salts predominate largely over those of soda in the syrup, the former at least should accumulate gradually during the campaign and make their influence felt in a diminished output of sugar. But no such effect is shown by the record of the Alvarado factory, and the problem thus remains to be solved by farther investigation, which is the more to be desired, as an exact knowledge of what becomes of the salts may lead to a still farther improvement of the whole process. It would be necessary to start this investigation from the fresh juice, and follow it by the aid of analysis throughout its course, determining at the same time the average proportion, by bulk or weight, of each of the several products and by-products, in order to ascertain the actual *amount* of matter represented by each analytical statement.

Examinations of Oranges and Lemons.

In the analyses of oranges heretofore made and published, here as elsewhere, it has been assumed that substantially only two kinds of sugar—cane and fruit sugar, or sucrose and levulose—exist in the orange juice. Upon this supposition the determination of sugars has been usually made by the optical method, and the sugar contents of good oranges have thus been found to range somewhere between seven and eight per cent.

Some apparently discrepant results obtained in this manner having called my attention to the subject, three batches of oranges were purchased in the San Francisco market, in March, 1886, and the solid contents of their juices tested by the various methods in use for the determination of the several sugars, including therein the grape sugar or glucose.

It soon became apparent that, although the oranges used were not of any unusual excellence for their kinds, much larger aggregate amounts of sugar existed in them than shown by the optical method alone. After a number of discrepant results obtained by various methods, the most reliable results for the three varieties stood thus:

	Cane Sugar.	Glucose and Levulose.	Total Sugars.	Citric Acid.
Riverside Navel	6.50	5.50	12.00	.78
Mediterranean Sweet	4.60	5.75	10.34	.86
Riverside Seedling	4.35	4.46	8.81	.98

These figures for total sugars are so far above any of those previously obtained, that it is clear all the latter must be regarded as materially below the real percentage of the three sugars. It is true that the glucose, of which the omission so lowered to previous figures, adds but little to the sweetness of the fruit, that being mainly due to the other two. But the discrepant results shown in the tests made with some of the oranges from Northern California showed clearly that the relative proportions of the sugars vary not only in different varieties, but also in one and the same variety at different degrees of maturity; so that, as no constant ratio exists between them, it will be necessary to determine each of the three hereafter.

Until this is done it will be necessary to regard only the figures for "cane sugar," in the first table below, as a correct result; while those given for "total sugars" can only serve for an approximate comparison of the different fruits with one another, and not with those of the table given in connection with the "Citrus Fruits of Northern California," the latter being based upon the spindle indication of the juice, as is done in the case of grapes; deducting, however, the ascertained percentage of citric acid. In this form all the figures are undoubtedly somewhat too high, since other soluble matters existing in the juice influence the spindle reading; but in any case, they will serve for comparison among themselves.

(BULLETIN No. 39.)

Analyses of Oranges and Lemons from the Riverside Citrus Fair, March, 1885.

These fruits, with the exception of those marked (*a*) and (*b*), were received through the hands of Mr. Charles H. Dwinelle, on his return from the fair. All were in excellent condition and were worked during the days following April third, the day of receipt.

The samples marked (*a*) and (*b*) formed part of a collection received some time afterward, through the courtesy of Mr. J. E. Cutter, W. H. Backus, J. H. North and other exhibitors, of Riverside. They were kept on shelves in a room until May fifteenth, when the Navel had lost some of its original firmness and the Malta Blood was beginning to show shrinkage from drying. These samples had therefore been kept six weeks longer

than the others, but were in good condition. Four of the Navels still on hand at this date—May twenty-second—though soft to the touch are perfectly sound.

The data given in the table below explain themselves. Column No. 1 gives the average weight, in grams, of the fruit examined, usually two in number; a division by thirty gives this weight in ounces avoirdupois. Columns 2, 3, and 4 give the percentages of rind, pulp, and seed, respectively. It will be noted that the Navel and Malta Blood oranges and Eureka lemon were found seedless, the largest proportion of seeds being found in the St. Michaels' orange. Column 5 gives the per cent of juice in cubic centimeters, referred to the weight of the fruit in grams; and since the density of the juice is somewhat above that of water, this percentage, if taken by weight, would be a little higher than here given; but for the practical comparison the figures hold good. Column 6 gives the actual amount of juice obtained per single fruit, again in cubic centimeters, which, by division by the number thirty, may be reduced to fluid ounces. Columns 7 and 8 give the percentage in the juice of cane sugar (sucrose) and fruit sugar (levulose), the sum of sugars being shown in column 9. Column 10, finally, gives the percentage of acid calculated as citric acid.

Analyses of Citrus Fruits.

Name.	1. Average Weight in grams	2. Rind, per cent.	3. Pulp, per cent.	4. Seeds, per cent.	5. Juice, per cent, c. cm.	6. Average amount of juice, c. cm	7. Sugars. Cane, per cent.	8. Sugars. Fruit, per cent.	9. Total Sugar, per cent*	10. Acid, per cent.
Oranges.										
1—Mediterranean Sweet	288.0	33.5	65.6	0.9	------	------	4.47	1.67	6.14	1.10
2—Riverside Navel (*a*)	283.7	30.0	70.0	------	41.42	117.5	5.04	2.10	7.14	.92
3—Riverside Navel (*b*)	------	------	------	------	------	------	4.47	1.96	6.43	.86
4—Paper Rind or St. Michael.	158.0	17.3	80.1	2.6	52.58	82.7	4.09	1.68	5.77	1.01
5—Malta Blood (*a*)	139.0	26.8	73.2	------	48.55	67.5	3.92	1.81	7.73	1.52
6—Malta Blood (*b*)	------	------	------	------	------	------	4.01	1.55	5.56	1.34
Lemons.										
7—Lisbons	115.2	35.7	63.9	.4	43.40	50.0	------	------	------	6.79
8—Eureka	157.0	22.4	77.6	------	45.22	71.0	------	------	------	7.21
9—Limes	53.5	15.9	83.4	.7	56.53	30.3	------	------	------	6.86

* The figures in this column are all doubtless too low, from the causes stated in the discussion regarding the Northern California fruits, below.

1—Mediterranean Sweet orange, from W. H. Backus.
2—Riverside Navel orange, from John W. North. Taken from a plate of fine oranges which received the first prize for the best budded orange and best orange on exhibition.
3—Riverside (or Australian?) Navel orange, from J. E. Cutter.
4—Paper Rind or St. Michael orange, from W. H. Backus.
5—Malta Blood orange, grower not mentioned.
6—Same, grower not known.
7—Lisbon lemon, from E. W. Holmes.
8—Eureka lemon, from same.
9—Limes, from W. H. Backus.

These analyses show some interesting and important points of difference between the several fruits. The Navel shows the highest total sugar and lowest acid of all; and this is true equally of the earlier and later samples, *a* and *b*. The Mediterranean Sweet stands next in sugar percentage; its acid is a little higher than that of the St. Michaels in absolute percentage,

but the proportion between sugar and acid is practically identical in the two, the juice of the St. Michaels being a little weaker in both substances. The Malta Blood is a little lower in sugar than the St. Michaels, but exceeds it in acid by 50 per cent in the earlier sample.

It thus would seem that, apart from its inviting outward appearance, the Riverside Navel owes its place in public favor to three chief points: A high degree of sweetness, with a low degree of acid, and the firmness of flesh which invites it to be actually eaten instead of "sucked," as one is tempted to do with the other softer oranges.

The Mediterranean Sweet and the St. Michaels dispute precedence, according as individual tastes differ in respect to size and flavor; but the St. Michaels seems to have a greater firmness of flesh in its favor. The refreshing acidity and peculiar flavor of the Blood orange place it in a different category from the other three.

The first six columns, however, furnish food for additional considerations, especially when oranges are sold by the piece, or thousand, and not by weight. The Mediterranean Sweet shows a slightly heavier weight than the Navel, but the larger proportion of pulp in the latter more than makes up for the difference. Owing to an accident, the proportion of juice to pulp was not determined in the case of the Mediterranean Sweet; in the Navel the figures show it to have been about 59 per cent, whereas in the St. Michaels it goes as high as 65.6; in the Malta to 66.3 per cent. The latter two are, therefore, quite materially more juicy than the Navel, hence more delicate in transportation. The St. Michaels shows the highest percentage of pulp of all, notwithstanding the relative abundance of seeds; and hence a given weight of this variety would furnish the largest amount of eatable pulp, while if bought per thousand the light weight of the fruit would leave the consumer materially "short," as compared with the Navel or Mediterranean Sweet.

Comparing the earlier fruit with that analyzed six weeks later, there is in the case of both the Navel and St. Michaels a decided decrease of both sugar and acid; exactly the reverse of what would have been looked for, as these ingredients might have been supposed to be concentrated by evaporation. There is, therefore, a true deterioration in oranges kept beyond the point of proper ripeness, that amply justifies the preference of consumers for the freshest fruit.

As regards the lemons, the comparison between the Lisbon and Eureka tells strongly in favor of the latter. It is larger and has a higher percentage of pulp as well as of juice, while at the same time the latter is considerably richer in citric acid. Assuming 7 per cent as the usual average, it will be noted that the Eureka is nearly as much above it as the Lisbon is below. The limes stand nearly at the same point as the Lisbon, but show a considerably higher proportion of pulp as well as of juice than either of the two lemons, being fully 13 per cent above the Lisbon in the latter respect.

While these comparisons will probably hold good in general as between these varieties, the absolute figures (percentages) must be taken with allowance for the peculiarity of the season of 1884, with its unusual rains and low temperature, A reference to the analysis made in 1879 (see the report of the College of Agriculture for that year, pp. 59 and 60) shows a much higher average of both sugar and acid for the oranges, and of acid for the lemons; the proportion of pulp also seems to have been higher throughout.

Analyses of North California Citrus Fruits.

It has seemed of considerable interest to make use of the opportunity afforded by the exhibitions of citrus fruits from North California, held successively at Sacramento and San Francisco, in the month of January, 1886, to ascertain the characteristics resulting from the climatic differences between South and North California. Quite a number of chemical examinations of South California citrus fruits have been made in successive years, and published in former reports and bulletins of this department, so that a fair basis for comparison exists on that side. For obvious reasons, however, the results given below cannot be taken as representing correctly the possibilities and averages for North California, where but few localities have endeavored, as yet, to produce choice fruit under special care in cultivation or selection of varieties. What the exhibition *did* demonstrate, to the surprise even of North Californians, is that the citrus trees are hardy, and will bear abundantly, in numerous localities as far north as Shasta County; and that with a proper selection of varieties, sweet and high-flavored oranges, and lemons, not inferior in their acid contents to the average of those of South California, can be placed on the market several weeks in advance of the southern fruits. That ungrafted trees, planted for ornament and as curiosities rather than with any serious expectation of fruit, should have furnished a large proportion of the latter with low sugar contents and high acid, in semblance of the wild stock, was to be expected, and proves nothing as to what careful selection and culture may accomplish, while the cases in which really good fruit was shown are irrefragable proof of the possibilities in the premises.

It is greatly to be regretted that the samples examined could not be obtained until after the termination of the exhibition at San Francisco. It is understood by the trade that oranges especially deteriorate materially after a certain period, independently of any actual decay; and in special tests made in this regard last season, it was shown that this deterioration manifests itself in diminution of both sugar and acid, as well as in a loss of flavor. The fruit gradually becomes tasteless. That these causes had, in consequence of the long keeping, influenced the samples examined, became apparent from their beginning to decay within a week or ten days after the analyses had been made. It is altogether probable that this decrease of sweetness is at first caused by the partial transformation of cane sugar into glucose, which is much less sweet. In judging of the figures given for sugar in the table below, it must be remembered that they are comparable among themselves only, and not with those of the previous table; being based upon the same mode of determination that is used in the case of musts.

Only a few of the samples were accompanied by any detailed statements, and of those received some appeared to belong to other exhibits; hence all are omitted. Two or three fruits were used for each analysis.

TABLE II.

Analyses of Citrus Fruits Exhibited at the Northern California Citrus Fair, San Francisco.

Exhibitor.	Town.	County.	Variety.	Exhibit Number.	Weight of Largest in grams*	Weight of Smallest in grams.	Average Weight in grams.	Weight taken for Analyses.	Rind, per cent.	Pulp, per cent.	Seeds, per cent.	Number of Seeds, average.	Juice, per cent.	Juice.				1.50 and Acid.
														Juice, c. cm.†	Specific Gravity	Solid Contents, by Spindle.	Estimated Sugar per cent, by Spindle.	Citric Acid, per cent.
C. C. Bush	Redding	Shasta		671	135	123	128.3	262	36.3	16.9	2.4	20	44.4	95	1.0470	11.63	10.68	.95
H. W. Allbright	Red Bluff	Tehama		685	265	191	225.5	508	24.8	16.7	1.7	16	56.8	252	1.0410	10.20	9.43	.77
‡Mrs. R. A. Fourman	Bidwell's Bar	Butte	Seedling		134	120	127.7	386	16.2	21.0	1.5	11	61.3	213	1.0505	12.47	11.30	1.17
L. Granger	Oroville	Butte	Large St. Michael	697	185	127	155.1	345	18.8	17.2	.5	4	63.5	192	1.0460	11.40	9.95	1.45
Employés of Bank of Rideout, Smith & Co.	Oroville	Butte	Large St. Michael		155	139	147.7	305	21.2	17.6	2.4	16	58.8	155	1.0420	10.44	9.46	.98
Unknown	Oroville	Butte	Unknown		203	162	179.6	365	20.9	17.6	.5	6	61.0	193	1.0460	11.39	10.50	.89
D. K. Perkins	Oroville	Butte	Seedling	224	255	236	245.6	501	27.7	15.8	1.7	18	54.8	248	1.0410	10.20	9.29	.91
W. T. Somers	Newcastle	Placer	Mediterranean Sweet	145	205	152	169.7	357	27.6	17.5	.7	5	54.2	164	-------	------	------	.89
W. J. Wilson	Newcastle	Placer	Navel		340	226	279.0	550	30.2	16.5	----	----	53.3	257	1.0400	9.97	8.80	1.17
Unknown		Colusa	Navel		347	213	261.6	572	20.6	17.4		----	62.0	307	-------	------	------	1.47
William Saunders	Woodland	Yolo	Seedling		228	219	224.6	455	29.0	20.0	1.4	11	49.6	196	-------	------	------	.82
C. B. Kimball	Marysville	Yuba	St. Michael		151	124	133.3	400	17.5	21.4	1.6	10	59.5	205	-------	------	------	1.36
‡Judge I. S. Belcher	Marysville	Yuba	Seedling		175	137	161.2	333	22.7	17.3	1.3	9	58.7	170	1.0380	9.48	8.15	1.33
Lady Superior Notre Dame Convent	Marysville	Yuba	Seedling	48	259	247	253.0	259	29.1	21.4	1.0	7	48.5	109	1.0400	9.97	9.54	.34
W. G. Duhig	Napa	Napa	Navel	701	259	201	226.7	461	35.4	14.6	----	----	50.0	188	1.0365	9.12	8.88	1.24
J. K. Fraser	Lakeport	Lake	Mediterranean Sweet	626	155	134	141.2	295	29.0	17.3	1.3	9	52.4	130	1.0440	10.92	9.65	1.27
Mrs. S. E. Shaw	Cloverdale	Sonoma	Graft, unknown		148	144	146.3	295	29.5	16.3	1.2	8	53.0	133	1.0460	11.39	10.01	1.38
John Tyler	Portersville	Tulare			195	170	182.3	377	23.7	19.6	1.6	12	55.1	170	1.0510	12.59	11.73	.86
J. Gaub	Oroville	Butte	Pumalo	194	348	341	344.5	348	33.0	15.0	5.0	64	47.0	143	1.0380	9.49	------	1.92
James Shinn	Niles	Alameda	Lemons		197	169	183.0	366	29.2	16.1	1.1	13	53.6	160	1.0450	11.15	------	6.02
James Shinn	Niles	Alameda	Lemons		125	125	125.0	250	40.0	15.3	.4	5	44.3	94	1.0390	9.74	------	6.16
‡Mrs. E. B. Crocker	Sacramento	Sacramento	Citron lemon	443	83	79	81.7	245	19.7	22.3	9.5	48	48.5	§58	1.041	10.20	------	4.62
‡Mrs. William Karr	Marysville	Yuba	Lemon		120	100	107.0	220	13.2	19.2	.8	9	66.8	124	1.0410	10.20	------	6.79

*Thirty grams are equal to one ounce avoirdupois.
†Thirty cubic centimetres are about equal to one fluid ounce.
‡These samples were considerably dried.
§Besides the juice, as commonly extracted, there were thirty-five cubic centimetres of a thick mucilaginous substance.

Without accepting as definite the conclusions that might be deduced from the above table, it shows some points which may be taken at least as useful hints in regard to the selection of varieties for culture in Central and Northern California. In the analyses made of oranges from the Riverside Citrus Fair (see above: the Navel orange), as well as in former ones, the Navel orange appeared preëminent in respect to a low percentage of acid, which, with high flavor and usually also a high sugar percentage combined with other qualities, secures for that variety marked preference in the market. It is curious to note in the analyses made of northern-grown Navels, that this difference in favor of the variety is not maintained; that its acid percentage is throughout above 1.0, and its sugar contents below that of several seedlings, as well as below that of the samples of "Mediterranean Sweet." That this should be so is not more surprising than that certain grape varieties that yield excellent results in South California are of little value in Central and North California. And it is equally well known that, as a rule, orange trees grown with irrigation in Southern California do not do well north of Fresno at least, and are liable to suffer from frost when trees of northern growth are not in the least injured. The growers of citrus fruits in Northern California must determine for themselves what varieties come to perfection in their climate, and, *a priori*, should perhaps distrust somewhat those that acquire great perfection in a climate like that of Riverside, so different from theirs. So far as analysis can determine the point, the best showing in the table is made by the seedling fruits and unnamed varieties, the maximum sugar with the lowest acid being recorded from Portersville, Tulare County. Next to these are the Mediterranean Sweet, from Lakeport, and the Large St. Michael, from Oroville—a locality noteworthy for the low acid and high sugar, in three out of four cases. Looking over the column of acid percentages in oranges, there is no reason to fear comparison with Southern California at large. The average for the seventeen determinations here recorded being 1.10, almost the identical figure obtained in averaging the data from the south. In lemons the acid average is somewhat low, although in one case the goal of seven per cent is nearly reached.

It is to be hoped that during the coming season a fuller examination of the citrus fruits of North California will be made under more favorable conditions.

Utilization of unsalable Limes and Lemons for the manufacture of Citric Acid. I have heretofore repeatedly called the attention of growers of citrus fruits in California to the propriety of utilizing their surplus and refuse limes and lemons in the manner practiced in the Mediterranean countries, for the production of essential oils, and by either reducing the juice to the concentration required for shipment as "lime juice," or, should the market for that article be inadequate, to reduce the citric acid to the portable form of its combination with lime—citrate of lime—which would be readily bought by the manufactories in the East, or by those which doubtless would on that basis be established on the Pacific Coast. These subordinate sources of returns from fruit otherwise unsalable or unprofitable, are among the many minor industries which are perfectly practicable in this State, but are still popularly esteemed too small to command attention. This might be so long as extraordinary profits were the order of the day, and fortunes were made in a few seasons. But now that a more stable and healthful industrial condition is rapidly being established, it is time to look after what is now deemed to be, or at least is treated as, mere refuse. Even now the cost of labor is not so far above that of the rest of the United

States that it need stand in the way of this kind of enterprise, provided only that it be managed with a reasonable degree of financial and technical skill. The manufacture of the lime citrate and essential oils of lemon resp. orange, should whenever possible be combined.

Since efforts to prepare lime juice have not been successful, financially, on account of a limited market already fully supplied with the Tahitian product, I suggested to several persons the preparation of the lime citrate by the usual process of saturating the juice at a boiling heat in proper tanks. The cost of such tanks has stood somewhat in the way of action upon the suggestion.

Within the last year, the following communication on this subject was made to the *Technical Society of the Pacific Coast*, by Mr. Fr. Gutzkow, who has experimented practically upon a new method for the preparation of citrate of lime that commends itself for its extreme simplicity and cheapness, but which, with rare disinterestedness, that gentleman declines to patent, so that its use is open to all. The description of the process is best given in Mr. Gutzkow's own words, in the communication above alluded to, and with a very little practice, it can doubtless be so managed as to produce a good merchantable article on the small as well as on the large scale. A sample furnished by Mr. Gutzkow to the Agricultural Museum is of excellent quality and would command a good price in the general market.

[From the minutes of a regular meeting of the Technical Society of the Pacific Coast, held May 1, 1885.]

Mr. Fr. Gutzkow made a verbal communication on the subject of a method of preparing lemon juice for market:

Mr. Gutzkow said that, "Having been informed that sooner or later our farmers in Southern California would desire to know of a practicable way to prepare lemon juice for the market, he had given the matter some attention and was able to present a cheap and reliable method to achieve the purpose. It consists in boiling the juice in a copper kettle to a certain strength, as indicated by a spindle, and to pour the still hot solution on a layer of carbonate of lime or hydrate of lime spread on the floor. After mixing, like making ordinary mortar, the mixture, after twenty-four hours or less, becomes perfectly dry, and can at once be filled in barrels. The effervescence of carbonic gas, when the carbonate of lime has been used, or the heat generated when the hydrate of lime is employed, cause the evaporation of the water which remained in the concentrated juice. The proportions employed are approximately as follows: 120,000 lemons furnish 1,000 gallons of juice which are boiled into 100 gallons. This is mixed with 560 pounds of powdered chalk or 313 pounds of lime, previously slaked in about 100 gallons of water, and yields in either case 1,000 pounds of the salable citrate of lime which will contain between forty and fifty per cent of citric acid.

As there exist on this coast no chemical works where the citrate could be worked into citric acid, the product would have to be shipped to England. I am not yet able to give a reliable figure of the price which it would bring before shipment—probably somewhere between 5 and 10 cents a pound. Respecting the choice between lime and chalk as absorbent, I can only state that the former would be cheaper for us and the latter more acceptable to the manufacturer. Compared with concentrated juice, which is the usual form of shipment from Italy, the citrate of lime will be greatly preferable, because in the further manipulations for making citric acid the juice has to be converted into citrate of lime anyhow, and because the citrate does not admit of any adulteration. Owing to the frequent adulteration of the juice with sulphuric acid, the amount of which cannot be determined by a plain assay, and to the fact that the juice arrives frequently in full fermentation, the English manufacturers have tried repeatedly to induce the Sicilian farmers to ship the juice as a citrate of lime. But the usual method requires a steam-boiler and some chemical knowledge. Besides, the citrate of lime obtained by the old way is difficult to dry, and when wet decomposes as easily as the juice itself.

Citric acid is used in calico printing and for medicinal purposes, and sold in this market at about 75 cents a pound. If cheaper, it could be used with much advantage instead of bitartrate of potash in baking powders. To set the carbonic acid free from one pound of bicarbonate of soda, 2.24 pounds of cream of tartar are required, and only .83 pounds of citric acid.

According to the "Reports of U. S. Consuls" for 1882, the values of shipments from the single port of Messina in Italy were in 1882:

Lemons and oranges	$1,765,000
Essential oil	1,387,000
Concentrated juice	496,516
Total	$3,648,516

It may be questioned whether on the basis of the figures used by Mr. Gutzkow in his calculation, the production of the lime citrate would pay. According to the data obtained in the examinations made at the University Laboratory, it would not take nearly 120,000 lemons, on an average, to yield 1,000 gallons of juice; and the price of 10 cents per pound for a product which with a very simple process will yield 50 per cent of citric acid, seems excessively low. There seems, moreover, to be no good reason why this last transformation should not be carried out on this coast, thus saving the cost of export.

Tests for Arsenic on Apples Sprayed with Arsenical Washes.

Several persons in Santa Clara County having, early in the season, sprayed their apple trees with a solution of white arsenic in potash lye, with a view to killing the eggs of the codlin moth, the question was raised whether an objectionable amount of the poison might not remain on the outside of the apples, especially within the calyx and around the upper end of the stem.

One sample was sent by Mr. T. C. Settle of San José; another came from Mr. G. W. Ousley of San José, through Mr. W. G. Klee, the State Inspector of Fruit Pests.

A dozen apples of each lot were carefully rinsed with a jet of hot water at both ends. The risings were evaporated and then tested in a Marsh's arsenic apparatus. Not a trace of the poison was indicated by the test.

If, instead of the soluble arsenite of potash, water charged with Paris green or London purple had been used, particles of the powder of these poisons would, doubtless, have been retained in the calyx and ends at least; while in the case of the perfectly soluble compound, the solvent action of the dews and fogs had evidently gradually removed the whole. The same, of course, would be true more certainly wherever summer rains occur.

It thus appears that even in the dry climate of the California Coast Range, the small amount of any soluble poison that may have been applied in the early stages of the growing fruit, will be removed before harvest time.

Sulphide Whale-Oil Soap for Summer Washes. The "whale-oil and sulphur" wash has for some time past enjoyed a good reputation as an insecticide, impaired only by failures due to varying material used. Its effects have, however, been found too weak and transient for many of the hardier pests, and its effects have been strengthened by lye added to the wash. It had been noted at the University that the effects were much enhanced when the wash was boiled after adding the lye, the chemical effect being in that case the formation of sodium sulphide, which acts much more energetically than the sulphur undissolved. To enhance the effect, I prescribed that a certain proportion of lye and sulphur should be boiled together before being added to the soap, the proportion used being three pounds of American concentrated lye boiled with six pounds of sulphur, and then added to a solution of thirty pounds of "Arctic" whale-oil soap, containing twenty per cent of water, to one hundred and fifty gallons of water. This wash worked very well when made up on the spot, and

proved effectual against all the kinds of scale found on the University grounds, save the hard, armored individuals.

It was found, however, that when the ingredients were thus prepared and intermixed with a small proportion of water only, for transportation, the soap and the sulphide solution would separate from each other, and unless used subsequently as a whole, successive portions taken from a can would vary in composition and be either too strong or too weak.

Experiments were, therefore, made to ascertain what proportion of the ingredients must be used to form a mass that would remain solid and uniform during transportation, and after numerous trials the following proportion was found to give the most satisfactory results:

Water	41 parts.
Whale-oil soap (20 water)	45 parts.
Concentrated lye	2.5 parts.
Sulphur	2.5 parts.

The sulphur is first dissolved in the lye by boiling with from four to six quarts of the water, and the whole, with the rest of the water (needed to bring the whole up to about fifty per cent of moisture), is then mixed with the soap. The above amount in pounds would make about two hundred and twenty-five gallons of wash.

The preparation thus made is soft enough to be easily dissolved in water, and remains perfectly uniform under the shaking of transportation. At the same time it is much more effectual than the old mixture containing only undissolved sulphur, and does not affect the leaves, unless while exceedingly tender, in Spring. For citrus and other evergreen trees with leathery leaves it may be still farther strengthened by the addition of say a pound of lye per one hundred gallons of wash, after it has been made ready for use in the spray pump.

APPENDIX II.

REPORT ON GRASSES, FORAGE PLANTS, AND CEREALS.

By E. J. Wickson, Lecturer on Practical Agriculture, and Assistant Superintendent of the Agricultural Grounds.

Professor E. W. Hilgard:

Sir: I herewith submit a report upon the work in my department.

Respectfully,

E. J. WICKSON.

GRASSES AND FORAGE PLANTS.

One of the first efforts of the College of Agriculture, after suitable facilities for the systematic trial of economic plants were secured, was to discover plants which would prove of value in improving the pastures of the State. The natural pastures of California, though rivaling in abundance and nutritiveness of growths those of the most favored countries of the world, prove not durable, because such a great proportion of the native plants are annuals, and consequently depend upon yearly seeding. Such being the case, they are speedily ruined by close feeding. The demand of the grazer and dairyman for "root grasses" instead of "seed grasses," was heard early; or in other words, it was soon seen that perennial grasses which would thrive in this climate were a desideratum. More than this, the annuals which spring up so closely after the first rains and grow with such luxuriance during the winter and spring, ripen early, and furnish only "dry feed" during the long summer. Though this "dry feed" is very nutritious and excellent for work animals, or for fattening stock, it is deficient in succulence, and consequently not so well adapted to maintain the full flow of milk through a long season, which is so important to the dairyman and general farmer. For these reasons, it was determined early to make a study of forage plants, and to introduce for trial whatever could be secured of a promising character from other parts of the world. This determination has been emphasized from time to time by the calls made upon the college by farmers for help in this direction, of which the following, from a letter written by F. H. Babb, of San José, will serve as a fair sample:

> What I have been seeking for years is a forage plant, the roots of which will live from year to year on these foothills (five miles east of San José). The annual grasses are soon pastured out. Sown grain is expensive, and soon exhausts the soil, and much of the land can only be plowed and sown with difficulty. If the University can discover and introduce a grass whose roots will live even if the top dies down, it will be a great boon to owners of pasture land in this State.

Also the following from Raymond Plasse, of Jackson, Amador County:

Our pasturage is giving away. We have no longer the feed that we had twenty years ago. Our stocks are becoming smaller every year.

The reports of the College of Agriculture show that since the establishment of the Garden of Economic Plants, in 1879, the introduction and trial of forage plants has been kept in mind. The report for 1879 shows that thirty species of grasses and clovers were sown, and about twenty other plants of possible value to the stock grower and dairyman. Since that time many additions have been made to the list, and larger space given to some of the most promising plants, from which seed has been grown for distribution. It was early seen that experiments to determine definitely the value and adaptability of forage plants to large areas of the State could not alone be made in the Bay climate, in which the University farm is located, and the distribution of the seed, to those willing to conduct experiments and report results, was begun some years ago. The result has been that we are able at this time to report results attained with different plants in widely distant regions, and in this way to point out approximately in what districts certain plants may be commended for planting, and the uses they will serve.

SORGHUM HALEPENSE.

This plant has passed through such a confusion of names, both botanical and popular, that we have concluded to give sole honor to the one botanical name to which it seems entitled. The College of Agriculture received the plant at first from widely different sources, and Mr. Dwinelle, in his reports, chose to accept the name under which it came from New Zealand—*Panicum spectabile*—and called it "Angola Panic," as a convenient and proper title. Other supplies came as *Sorghum Halepense.* After several years growing the two plants side by side and endeavoring to distinguish between them, it seems beyond doubt that the two are identical, and that *Sorghum Halepense* is the proper classification and name. Popularly the plant has been distributed as "Evergreen Millet," "Green Valley Grass," "Means Grass," "Johnson Grass," etc. Another point of interest is that there is even more confusion in the estimates of different growers as to the desirability of the plant than there is in its proper naming.

This plant was so widely heralded in the agricultural journals that when the roots were first offered by the College of Agriculture there was a great demand for them from all parts of the State. The reports which we present in condensed form below show that the plant has been tried in all parts of the State, and under all conditions of soil and climate. A careful study of these reports will convince the reader that the value of *Sorghum Halepense* in California is on the whole a matter of grave doubt. In the first place it shows itself to be very sensitive to atmospheric conditions, and that it is likely to be killed by the frost. Frost is assigned as the cause of its failure in Mendocino, Del Norte, Lassen, and Mono Counties. In the valleys the measure of its growth seems to be proportionate to the amount of water supplied, and in the upper end of the Sacramento Valley it seems quite unsatisfactory, unless on land naturally moist or irrigated. On dry hillsides in all parts of the State it in most cases perishes from drought, or makes an insignificant growth. On the other hand, it dislikes excessive moisture, and is reported killed by overflow in Los Angeles County. Another direction in which it has proved disappointing is in its tardiness of growth in the spring and early cessation in the fall. This could, of course, be overlooked, if it were generally good during the dry summer, but it has proved itself more exacting in conditions for summer

growth than many other forage plants. If to these doubtful values be added the difference in opinion among practical men as to its feeding quality and its persistent hold upon the soil where it finds conditions suited to it, and we are inclined to pronounce judgment against the general desirability of the plant. For more specific account of its behavior and value under certain conditions we refer to the following extracts from correspondence:

N. H. Gregory, Bodie, Mono County.—Millet roots planted in May failed to grow. It is too cold here.

William Haddox, El Monte, Los Angeles County.—Evergreen millet grows well on damp land, but on dry land it grows very short, and does not make the amount of feed that barley does with a fair amount of rain and is not equal to alfalfa on damp land. Cattle and horses eat it well, but I prefer to grow alfalfa.

Mrs. E. H. King, Napa.—The evergreen millet grows rapidly, and the seed blown onto new ground makes strong plants. Our land is gravelly hillside, warm, but light. Cattle, calves, and colts eat it and like it, especially when there is no other green feed, but horses do not care for it.

J. S. Wright, Willits, Mendocino County.—The long frosts we have here have completely killed out the evergreen millet. I do not think much of it as a forage plant, it is too coarse.

George Walton, Crescent City, Del Norte County.—After two years trial I am satisfied that evergreen millet is of little or no value in this part of the State. It grows quite rapidly in the warm part of the year, but does not ripen seed.

T. G. Turner, Lower Lake, Lake County.—Evergreen millet was a complete failure with me.

James Ramsey, Auburn, Placer County.—Evergreen millet was high enough to mow by May first, but pigs got in and made sad work of it. It grew again, however, and continued to send up fresh shoots until the rains set in. I think it will be highly prized on our hills.

J. J. Newkirk, St. Helena, Napa County.—Evergreen millet seed did better with me than roots, and last year the plant grew much more satisfactorily than this year (1885), as it has been very dry. The soil is a rich sandy river bottom.

F. H. Babb, San José.—I am convinced that evergreen millet is not the plant for stiff, dry soils.

J. Cunningham, Saratoga, Santa Clara County.—Evergreen millet seed and roots planted on clay upland both came up tolerably well, but most of it died during the first summer. That which survived stood the winter well, but died the next summer. On rich soil with water, the first year the plant has grown, borne seed, and spread; the second year, without water, has done well.

Chas. A. Storey, St. Helena, Napa County.—Evergreen millet roots on good, deep, sandy loam made an astonishing growth. From roots set last spring (1885) I have already (October seventeenth) cut two crops, and it is now six inches high. This is remarkable, considering the dry summer. Both cattle and horses are extremely fond of it when cut green.

George Mudd, Germantown, Colusa County.—I have made a complete failure in getting evergreen millet to grow, either from roots or seeds. Last spring planted roots threw up a few blades, and these soon dried up, perhaps owing to the extremely dry summer.

C. W. Day, Aptos, Santa Cruz County.—Evergreen millet on a sandy hillside, northerly exposure, receiving no moisture after planting but from fogs. have kept alive and show very nice green color. They seem to promise a good growth after the rains. The wonder is that any of them retained their vitality.

William Still, Sonoma.—Evergreen millet does well when plenty of water is given, but has lived through the summer without any, and looks as though it would be suitable for Sonoma.

W. H Mullen, Big Bend, Butte County.—The evergreen millet has never done anything where I put it, although it is growing. I think the place is too dry, but that is just the kind of ground that I wish to get into green grass.

P. W. Arnold, Redding, Shasta County.—The evergreen millet does tolerably well on the good bottom land, but I have no success with it except when I water it continually.

William F. Somers, Lugonia, San Bernardino County.—Stock does not eat the millet well when green. When cured as hay they eat it. When the ground is full of roots I propose to turn my hogs on it in winter, and in summer cut it for hay. It is a mistake to recommend it as good for pasture.

H. V. Sherman, Hill's Ferry, Stanislaus County.—My experience does not impress me favorably with evergreen millet. It starts very late in the spring, and the first frost cuts it to the ground in the fall. Stock will not eat it as long as they can get any other green forage. Hogs will eat the roots, but this I do not approve as the hog has to labor for his food. It grows entirely too rank for hay when irrigated, and without water it does not amount to much. I thing when it gets a hold in moist soil it will be hard to get out.

Rowland Machin, Lompoc, Santa Barbara County.—I have had good success with the evergreen millet on black, gravelly, hill land. I have an idea that it will be a good thing to fall back on in a dry year.

E. J. Delaney, San José.—The evergreen millet roots you sent last March did not do

well; I think because of lack of moisture in the ground, as we had very little rain after planting.

George A. Raymond, Alma, Santa Clara County.—The evergreen millet roots were planted on a hillside, southern exposure; soil, rather stiff yellow clay, from which a growth of buckeyes have been cleared. The roots were planted with a spade, and hoed afterwards to kill weeds. They made a fine growth, and kept green until the frosts came. From my experience I should judge that the plan will prove valuable for forage on our dry hillsides, especially for those which are too steep for ordinary cultivation.

J. P. Jones, Newport, Los Angeles County.—The evergreen millet roots sent me were set out immediately and grew well, but the stalks were very woody. I gathered the seed and sowed it, but it did not come to anything. The old roots were overflowed in the winter, and I think were killed. Other parties here have tried the plant, and all conclude that it is not adapted to this climate, etc., or that it is a humbug.

A. C. Athearn, El Cajon, San Diego County.—Roots on dry ground grew from three to six feet in height; on wet ground about thirty inches tall. It does not start as early as the natural grasses here.

Edward Berwick, Carmel Valley, Monterey County.—This locality seems too cold for the grass. It has done absolutely nothing; has barely held its own against native grasses and clovers.

Mrs. John Boyd, Sheridan, Placer County.—The grass was doing splendidly until the grasshoppers ate everything down and into the ground.

F. Riley, Morro, San Luis Obispo County.—Have grown evergreen millet two years. It does well, and is an excellent forage plant. It will yield four tons of roots per acre; the roots penetrate to a depth of twenty-four to twenty-eight inches. Gophers cannot kill it.

A. Plumley, Byron, Contra Costa County.—I planted the roots on a heavy black loam, where there was some alkali. The first year they grew very well. The second year I pastured it, and it did not do well. I do not like it for stock.

W. B. Atterbury, Jr., Santa Rosa, Sonoma County.—The roots were placed on poor soil, in a dry place, to test the plant. It grew well the first year, but this year it appears to have died out altogether, though protected from stock of all kinds. It does not seem to grow well, even upon the rich land on Santa Rosa Creek near here—not nearly so well as alfalfa on the same land.

J. Chrisman, Lower Lake, Lake County.—Both roots and seeds planted last spring (1885) grew for a time in several different kinds of soil, and then died out after the middle of September—perhaps because of the severe drought of the season.

W. E. Hughes, Fresno.—I planted the millet roots on sand soil, part where it had a great deal of water, part where it had little or none, and it grew well under both conditions. It does not make good food for stock, as they do not like it, except where young and tender. It seems better fitted to pasture hogs, as they are fond of the roots.

L. L. Giess, Wrights, Santa Clara County.—On moist land it made a growth of about five feet; on the dry hillside it grew about four inches. I do not think it a success on dry land; nor is it much of a pasturage, except for hogs.

Raymond Plasse, Jackson, Amador County.—From evergreen millet roots I gathered seed the first year of growth, and sowed it in March, 1885. There was only one rain after sowing, but the growth was good for such a season. It stands the drought, is not destroyed by gophers, and the grasshoppers destroyed everything on our place except the evergreen millet. I regard it as *the* plant for dry ground on the foothills. I have half an acre, and will sow all the seed I gathered this year. For forage and pasturage the horses, cattle, and sheep like it.

Albert Fouch, College City, Colusa County.—The plants made a growth of five feet the first year from the root.

William Walker, San Gregorio.—The evergreen millet grew about four feet high and seeded nicely. I cut it, and it is now (October twenty-sixth) growing, and about six inches high. The soil is light and sandy; sediment soil, right on the bank of a creek. I think it will do well in this part of the State.

L. Jared, San Miguel, San Luis Obispo County.—Only about half the roots grew. We have a hot climate and rather dry soil. I think it will not be seen at its best here, except in some places favored as to moisture.

Benjamin Sanford, Smartsville, Yuba County.—Evergreen millet is a success, except that the top makes indifferent feed, green or dry, for cattle and horses. It grows well and stands irrigation well. Hogs are very fond of the roots.

E. M. Dewey, Tulare.—I believe there are two kinds of evergreen millet. I think there is a plain difference in the seed, though the roots are alike worthless for hog feed. I have but a quarter of an acre, but I would give several acres of land to be rid of it.

John McNeely, Redding, Shasta County.—The evergreen millet grew and kept green all summer. The farmers in this vicinity are very much in favor of planting it.

Ransome Greene, Alma, Santa Cruz County.—The evergreen millet planted in April on the south side of a steep hill, in very dry red soil, had no rain after planting. The plants lived and some seeded. I think it will prove valuable.

C. S. Babbitt, El Paso, Texas.—Evergreen millet, from roots, grew six feet high; that from seed sown at the same time grew seven feet or more. Neither roots nor seed received any water after planting. We do not think of growing anything here without irrigation, and the growth of this plant is very gratifying.

D. F. Newson, Arroyo Grande, San Luis Obispo County.—I planted evergreen millet on good bottom land and did not get the seed back; but on a dry rocky point, which did not produce anything, it grew and gave satisfaction.

E. A. Bosworth, Cayton, Shasta County.—I have tried the millet roots, with great care and on good soil, but succeeded in getting but few plants to live, and they did not make much growth.

W. B. Fielding, Los Gatos, Santa Clara County.—I planted evergreen millet roots on a northern slope in the spring of 1884. It grew luxuriantly the first season, but was entirely killed by frost the following winter. The soil is a rich black loam, with some gravel.

Martin Kirby, Darrah, Mariposa County.—Evergreen millet has grown well when water is given it. It appears to grow or not to grow in exact proportion to the drought or irrigation.

George Behrns, Garden Valley.—Of the millet roots which I planted in dry unmanured soil, some died, others grew five or six inches high. I gave half the roots to a friend, to plant in rich soil, where I expect it will do better.

G. C. Swan, National City, San Diego County.—The millet roots were put on high mesa land, and some of them started; but the heavy rains of 1884 did not agree with them, and they all died.

J. E. Hallett, Janesville, Lassen County.—I planted evergreen millet roots the last of April, and they grew finely to a height of four feet, but the first frost killed them, root and stem, as they never appeared afterwards. We have cold winters, the mercury sometimes 20° below zero.

Charles Brockelsby, Goleta, Santa Barbara County.—I have nothing to say in favor of evergreen millet. It does not give green feed when it is needed. I prefer millomaize to anything yet tried as dry weather feed, on good soil where water cannot be had.

SHRADER'S BROME GRASS.

This grass has given general satisfaction, both for its early starting and good winter growth, and for its persistence in summer growth and drought-resisting qualities. It has been distributed from the University for a number of years, and the reports from growers are overwhelmingly in favor of the plant. They warrant us in commending it for trial on a commercial scale.

As the grass is destined to be much better known and more generally distributed, we shall note a few points of its history, and the observations of its value in other parts of the world. It was, apparently, first brought to the notice of agriculturists of the United States by B. V. Iverson, of Columbus, Georgia, in a letter which he wrote to the U. S. Commissioner of Patents, in November, 1853.* Mr. Iverson gave a very high commendation of what he calls "my grass" as a winter grass; not injured by overflow, nor affected by ordinary drought, etc. It is unfortunate that Mr. Iverson does not state whence he obtained his seed, but that omission is sufficiently explained by his statement that he proposed to "sell the seed the coming year for $5 per peck." He evidently did not care to disclose the source of supply.

* Report of the Commissioner of Patents (Agriculture), 1853; page 212.

In the following report of the Patent Office are letters from those who have tried "Iverson's grass," and speak well of it.* A few years later, Mr. C. W. Howard, in an essay entitled "Grasses for the South,"† alludes to the plant as "Rescue grass," but pronounces it "inferior to common rye for winter grazing." He says it is cultivated in Georgia, Alabama, and Mississippi, and is indigenous and not very popular in Texas, west of the Brazos. The plant is afterwards occasionally mentioned in the reports of the Department of Agriculture until, in 1878, it is introduced by Dr. Vasey in his report on Grasses and Forage Plants;‡ an engraving of the plant and analyses of its composition being given in addition to the botanical description. It is interesting to note Dr. Vasey's statement, that in Georgia, where the grass was introduced by Mr. Iverson, it has not sustained the good opinion which was first formed of it, while in Texas, where Mr. Howard, in 1860, said it was "indigenous and unpopular," Dr. Vasey's report, in 1878, quotes a Texas authority to the effect that the grass is an "important discovery, and wonderfully adapted to supply just what is wanted—growing well on thin soils, crowding out weeds, making fine pasturage in February when other grasses are scant, and maturing in March and early April."

There is another chain of events in the history of this plant in this country. Although we do not find definite statement of the fact in the Patent Office reports, it is probable that the seed was distributed by the Government about 1854,§ or just after the announcement of its values by Col. Iverson of Georgia. This led to its carriage from this country to Australia. How this was done has been described in this way:¶

> The prairie grass (*Bromus Schraderi*) was brought to notice in New South Wales by the late Sir William T. Denison when Governor-General. A sack of seed was forwarded to his Excellency from California about the year 1855 or 1856. This was presented to the then existing Agricultural Society, of which he was President. It was distributed amongst the members, and the following year samples were shown by one of them, showing that it was suitable for culture as green fodder. * * * The grass is peculiarly well suited to the Australian climate, and already forms an important ingredient in most of the artificially raised pastures, besides having spread to a considerable extent among the natural pastures in the interior. It is worthy of still wider distribution, both as a fattening and dairy grass. * * * It is a grass which, like perennial rye, will, even under the ordeal of close grazing, gradually spread and fight its way amongst other grasses, either natural or artificial. This is shown by the fact that it produces seeds at every season of the year and of plants of very minute development. Seed panicles may often be seen on plants too short for horned cattle to bite, thus showing that it can multiply even under the close grazing of that kind of stock—a very valuable feature in any kind of grass. * * It certainly has the advantage over perennial rye in our hottest and most droughty districts, * * * and it will thrive under a greater number of conditions than any other grass we are at present acquainted with.

Making such a record in Australia, almost from its first planting there, about 1856, it is not strange that it was soon carried thence to various parts of the world and became known as an Australian grass. So it was considered upon the continent of Europe, and much interest was manifested in its growth. It is given in Vilmorin, Andrieux & Co.'s (Paris) catalogue for 1884 as *Ceratochloa Australis*, as a synonym for *Bromus Schraderi*.

It is an interesting fact that apparently unmindful of its experience with

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* Report of 1854; pages 191 and 193.
† Report of 1860; page 224 *et seq.*
‡ Report Dept. of Agr., 1878, page 169 *et seq.*
§ *Vide* Class Book of Botany, by Alphonzo Wood (edition 1869), page 791.
¶ The *Australasian*, quoted in *Pacific Rural Press*, June 16, 1883.

the plant in 1853, the Department of Agriculture alludes to it in the report of 1869* in this way:

Bromus unioloides (Schrader's Brome Grass). This Australian plant has lately been brought into prominent notice on the continent of Europe and in Great Britain, as likely to supersede the Italian rye grass for soiling, cattle, and for irrigating meadows, etc.

It was apparently reintroduced by the Department before 1865, for we find it enumerated among the grasses sown on the experimental farm in that year.†

In the year 1872 the grass was redistributed by the Department of Agriculture‡, the distribution being confined to the Southern States. The result of this distribution is given in the report of Dr. Vasey, alluded to above.

The history of the plant in California has as many peculiar features as its career at the East and South. Although all accounts agree that the seed was taken from this coast to Australia in 1856, it does not appear that the plant found any lodgement here at that time. Indeed, one is almost led to the surmise that some one may have passed along to Australia the seed which was sent for trial in this State. At all events, Mr. Bolander, in his report "On the Grasses of the State," to the California State Agricultural Society in 1864§ does not place *Bromus unioloides* among the grasses he finds here, but inserts this mention of it:

In Dr. F. Mueller's (Director of the botanical gardens at Melbourne) annual report, I find the following passage relating to a grass of this western coast. Amongst the latter, the so called "California prairie grass," *bromus unioloides* of Humboldt, has far surpassed in its yields all other kinds hitherto experimented on in this garden, and as a perennial species, of broad leaf and of nutritive properties, prolific even in dry ground, and capable of enduring the influence of our occasionally scorching summer heat, this grass is entitled to general introduction in our pastures.

In his "Select Plants,"¶ published at least sixteen years later than the report alluded to by Mr. Bolander, Baron Von Mueller writes:

Bromus unioloides, Humboldt. (*B. Schraderi*, Kunth.) In Australia called the prairie grass. From Central America to the sub-Alpine zone of Northern Argentina. It has spread over many parts of the globe. The writer saw it disseminated in the mountains of St. Vincent's Gulf as early as 1847. It is one of the richest of all grasses, grows continuously and spreads readily from seeds, particularly on fertile and somewhat humid soil, and has proved, as a lasting and nutritious fodder grass or pasture grass, one of our best acquisitions. Very early out in the season for fodder.

It is quite evident that the attachment of "California" to the plant was a misnomer. This fact, as well as the proper botanical classification, is shown by the following, from the Botany of California:‖

Ceratochloa unioloides, Beauv. (*Festuca unioloides*, Willd. *Bromus unioloides*, HBK., *B. Willdenovii and B. Schraderi*. Kunth.) Was at one time in high repute in France under the name of "Brome de Schrader," as a forage plant from Australia; at about the same time it was cultivated in Australia as "California prairie grass," and was introduced in the Southern States as "rescue grass." The species is South American, and is found in Texas and westward, but is not known to occur in California, notwithstanding its Australian name.

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* Report of Wm. Saunders, Superintendent of garden and grounds, Department of Agriculture. Report, 1869, page 89.

† Report, 1865, page 30.

‡ Report 1873, page 236.

§ Trans. Cal. State Agr. Society 1864–5, page 131 *et seq.*

¶ Select Extra-Tropical Plants, readily eligible for Industrial Culture or Naturalization, etc. By Baron Ferd. Von Mueller. Indian edition. Calcutta, 1880. Page 50.

‖ Geological Survey of California; Botany. Vol. II., page 322.

The foregoing record of the appearances of the grass in the United States seem to indicate that the writer in the California Botany was not aware of its introduction in 1853, which antedated its appearance in Australia.

All accounts of the plant, both from practical farmers and chemical analysts, agree as to the superiority in fattening properties of the plant. The account in the *Australasian** says "the following analyses were conducted by reliable persons, during the spring, when the herbage was in vigorous growth:"

Name of Grass.	Albumen.	Gluten.	Starch, with its Products, Sugar, etc.
Perennial rye	4.30	4.68	4.10
Cocksfoot	3.50	6.78	6.88
Schrader's brome	2.55	3.60	8.30

Professor Peter Collier, while Chemist of the Department of Agriculture, made analyses of a large number of grasses and forage plants. From his report† we take the analyses of *Bromus unioloides*, *Sorghum halepense* (because of its interest in connection with the mention made of it in this report), and place in comparison with each of them the average of the analyses of about thirty grasses and clovers which were examined at the same time.

Proximate Analyses of Grasses.

Name of Grass.	Oil	Wax	Sugars	Gum and Dextrin	Cellulose	Amylaceous Cellulose	Alkali Extract	Albumen	Ash
Sorghum halepense	2.25	.61	7.37	5.14	25.15	25.87	15.58	13.18	4.85
Bromus unioloides	2.99	.24	14.36	1.00	24.31	23.74	13.13	12.45	7.78
Average of 30 forage plants and grasses	1.92	.46	9.42	5.08	27.89	24.08	15.05	9.81	6.74

Ash Analyses.

Name of Grass.	Potassium	Pot. Oxide	Sodium	Sod. Oxide	Calcium Oxide	Magnesium Oxide	Sulphuric Oxide	Phosphoric Oxide	Silica	Chlorine
Sorghum halepense	3.68	35.72	.81	-----	12.87	6.73	2.96	10.44	22.21	4.58
Bromus unioloides	16.38	37.20	1.27	-----	4.43	4.64	5.61	8.79	4.84	16.84
Average of 30 forage plants and grasses	7.13	26.76	-----	-----	8.42	4.36	4.69	6.37	35.78	7.15

These analyses show clearly the high nutritive qualities of the plant under consideration; the high percentage of soluble nutrients and the low percentage of indigestible matters, such as cellulose and silica, rendering it exceedingly desirable. The food value of the seed is also an important item, as the production of seed is large and the nutritive quality well established.‡

* Republished in *Pacific Rural Press*, June 16, 1883.

† Department of Agriculture Report 1878, page 184.

‡ From an editorial article in the Auckland Weekly News (New Zealand), December 26, 1885, we quote the following: "The seed of *Bromus Shraderi* is greatly relished by cattle

The seed of Shrader's Brome grass, which was first sown in the University garden of economic plants, was received in April, 1880, from H. P. Flint, of Hueneme, Ventura County. From this has been produced the seed which has been used in our seed distributions. In answer to an inquiry as to where he obtained the seed, Mr. Flint writes, under date of November 10, 1886, as follows:

I obtained the seed from a Mr. Ensign, keeper of the Hueneme Lighthouse, about the year 1879. He told me he purchased the seeds from B. K. Bliss & Sons, of New York, because of this recommendation in their catalogue: "Shrader's Brome grass, a forage plant from Australia; particularly recommended for resistive drought; better than any other variety, and will thrive in any soil except where there is superabundance of moisture; yields two good crops in a season; 16 lbs. to the bushel; sow 25 lbs. to the acre; price, per lb., 50c."

Mr. Ensign purchased one pound, and from that only one stalk grew and matured seed, as the seed was probably old. He grew more from the single head he secured, and gave me a handful, which I planted, and the second year afterward I got all the seed I could get into a fifty-pound flour sack, and gave away three quarters of it—some to the University; some to other parties. Planted some two or three years later on dry land with wheat, for hay. The hay was light, and I lost my Brome seed. I received a new supply from the University and lost that too. The little experience I had with the grass convinced me of its value.

It thus appears that California received again the seed from Australia, via New York, and probably it reached New York via Europe—about a quarter of a century after it went to Australia via California.

The following notes from correspondents to whom seed was sent for trial from the College of Agriculture, show that early tests of it are very promising in most parts of the State:

L. C. Kinkaid, Encinitos, San Diego County.—I sowed the Shrader's brome grass seed March twenty-eighth, and it came up in ten days. It grew until it nearly covered the ground, when the quail ate it up. I am satisfied it will be a good grass in this part of the State.

A. J. Schultz, Brown's Valley, Yuba County.—The Shrader's brome grass I received from you last March (1886) has proved to me that it is a valuable grass and well adapted for our dry foothills. Although sowed late in the spring, it has made an excellent growth of more than two feet in height, and I have gathered nearly a bushel of seeds from about three ounces sown. The grass got perfectly dry in July, and now (October twenty-fifth), after our first little rain, it is coming up green and fresh from the roots. I sowed it broadcast, as I would oats, and it had no more attention.

William Anderes, Los Angeles.—I sowed the brome grass in well-prepared mesa land in March. It started and grew finely, but when about eight inches high my fowls found it and ate it off close to the ground. It seemed impossible to keep the poultry away from it. They ate it off as fast as it sprouted again from the roots. I planted it at quite a distance from my barns, but the fowls found it. I believe if any one wants to grow the grass they must fence the grass or the fowls, for they will just stay there and watch for it, and eat it off as fast as it starts.

H. D. Marshall, Folsom, Sacramento County.—The forage plants from the University have been tried by the sheep. None, excepting Shrader's brome grass, stay under all circumstances. It seems to be liked by all domestic animals, from cat and dog up. My location is on rolling lands, four miles north of Folsom, exposure south, with spring, on granite soil interspersed with red loam, and occasionally adobe.

Rowland Machin, Lompoc, Santa Barbara County.—Shrader's brome grass seems to be entirely at home on the black, gravelly hillsides where I tried it. My experience is that stock, *i. e.*, cows and horses, prefer it to any other grass, but, in my opinion, it should not be pastured for at least two years.

F. Frick, Paso Robles, San Luis Obispo County.—I plowed in the seed of Shrader's brome grass six or eight inches deep the last of March. It grew two feet high in a loose gravel soil. It produced abundance of seed. It is a success here.

L. B. Guill, Alturas, Modoc County.—Shrader's brome grass does not seem quite so hardy as Hungarian, but is as good for late pasture. The seed is not ripe yet (August 28). It should be sown early in the spring.

W. Clark, Madrone, Santa Clara County, writes: The *Bromus Shraderi* is a decided success. I find now (January sixth) green shoots as long as my hand. It is just the very thing we require in this locality—dry hill land, about fifteen hundred feet above the sea, in the

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and sheep; and, as it is rich in albumen, it is very fattening. Dr. Voelcker, chemist to the Agricultural College, Cirencester, England, places it as at the head of the artificial grasses in point of nutritious value, while as to yield, it may in fair soils be cut six or seven times a year, giving a heavy aftermath during moist seasons within six weeks.

Coast Range. From the little package sent I have secured a fifty-pound flour sack full of seed, which I am scattering here and there all over my grazing ground.

W. A. McKaig, Little Stony, Colusa County.—Shrader's and the Hungarian brome grasses have both done well, and promise to be valuable early grasses.

O. S. Phelps, M.D., Blocksburg, Humboldt County.—Seed of Shrader's brome grass were sown in dry hillside soil, in fertility about the average of the stock ranches of southern Humboldt. It has been the first drought in the county (1885), and no rain fell after the seed was sown, about May first. The grass has so far answered my highest expectations, viz.: for a perennial grass that will keep green through our dry season. I shall make further tests as to its winter growth, and its behavior under the tramping of stock.

John McCush, Garberville, Humboldt County.—The brome grass seed was received so late that I only planted part of it. It grew well and matured seed. I will sow more this fall. If it does well in winter, it will be quite an acquisition to our feed in this section.

W. A. Coulson, Christine, Mendocino County.—The Shrader's brome grass seed came up, but did not grow to much height because it was sown so late and the season (1885) was so dry. I think if it were sown early it would be a great blessing to this part of the State, for the native grass has been eaten out so that we will have to get some kind of grasses which will remain in the ground.

John Lowe, Janesville, Lassen County.—I sowed the brome grass seed in the spring of 1884, in sandy loam. It was slow to germinate, but finally nearly all came up, but made a poor growth of six to eight inches. The ground was rather dry in the summer and fall, and the grass has since dried out altogether.

S. B. Hatch, Ferndale, Humboldt County.—Shrader's brome grass seems to thrive here, but we have not had time yet to test it thoroughly. I like the appearance of it for hay, and I think it will make good pasture.

Mrs. L. S. Cleland, Mesa Grande, San Diego County.—Shrader's brome grass is a favorite with us. It has only one fault: the gophers are exceedingly fond of it.

HUNGARIAN BROME GRASS.

Seed of this plant was obtained from Vilmorin, Andrieux & Co., of Paris. It was commended both by French and German authorities as of quick growth, very valuable as cattle food, and resisting drought well. It is *Bromus inermis* of the botanist, taking its specific name from its awnless *poles*, or chaff free from beards. It is described by Loudon* as perennial; a native of Germany; abundant in cultivated soils in its native country; growing two feet high, and flowering in June and August. On the University grounds it has made good growth, both without and with moderate irrigation. On one plot in the University grounds, sown February 20, 1886, the seed germinated freely, and on October first hay was cut at the rate of four tons to the acre, and the plant made a good aftergrowth. The engraving will give a general idea of the appearance of the plant, although it shows a better leaf growth than indicated in the sketch, when grown in a favorable situation.

* Encyclopædia of Plants (1885), page 64.

The following notes are from correspondence with those to whom the seed was sent for trial:

F. S. Reid, Indian Valley, Monterey County.—The Hungarian brome grass was sunburned, and grew no better than the wild oats beside it.

W. A. McKaig, Little Stony, Colusa County.—While the Hungarian brome grass did well, it was entirely destroyed by poultry, from which I did not know that it needed protection. They are avariciously fond of it.

Peter Klink, Berryvale, Siskiyou County.—The Hungarian brome grass did almost nothing the first year. This year (1885) it grew about one foot high and headed. The season here is very short. From May to September fifteenth it is free from frost, but never very warm.

John R. Norris, Santa Maria, Santa Barbara.—Hungarian brome grass, sown on good sandy loam, made a good return. I would recommend it as a feed for stock. The grass is soft and rich, continues green a long time, and has a tendency to sprout from the root after being cut.

H. Beaver, Guerneville, Sonoma County.—The brome grasses grew until dry weather, and then dried up.

F. W. Breedford, San José.—I believe the Hungarian brome will prove a valuable grass. My experiment was interfered with by the chickens eating it out entirely; but I will experiment further with a new seeding.

L. B. Guill, Alturas, Modoc County.—The Hungarian brome grass seed was sown April thirteenth on shallow sandy soil, better known as sagebrush land. It can stand very dry soil, as it did not have any water near it. Wheat sown near it died. The first seed matured about August tenth, and it has continued ripening to date (August twenty-eighth). I am of the opinion it will make late pasture, as it seems to stand the frost.

MANY-FLOWERED MILLET GRASS.

Milium multiflorum.—The seed of this plant was obtained in 1879 from Dr. S. M. Curl, New Zealand. He did not state whence he obtained it, but the plant is put down by Loudon as a native of the south of Europe. The following record was made by Mr. Dwinelle of the first season's growth of the millet grass in the economic garden of the University:*

The grass grew to a height of two to three feet, and each plant formed a considerable bunch. Its deep, healthy green color, and delicate spreading panicles, made it admired by all who saw it. Drought seems to have no effect upon it. It is to be noted, however, that each plant had plenty of space about it, and the soil was kept free of weeds. When it has filled the plot, it may need water as well as other grasses. The heavy frosts which we have had have touched the extremities of some of the leaves only, although they are full of sap. This fact gives promise of a valuable addition to our resources in winter pasturage. * * * Dr. Curl reports the same hardness, as regards drought and cold, in his experiments with *milium multiflorum* in New Zealand.

Grown on the University grounds since the above record was made, the plant has continued in favor. It makes a great abundance of excellent forage, which, when cropped or cut young, is fine and tender, and practically frost-proof. Seeds have been distributed during the last three seasons, and reports have been, on the whole, very favorable. The seed is very small, and therefore requires care in starting, although under favorable climatic conditions, as described by Mr. Gird below, it takes care of itself if scattered abroad, and quickly asserts itself. Its behavior seems to be governed by conditions, for Mr. Kirby, in Mariposa County, describes its slow progress, but ultimate success. This accords with our experience with it in Berkeley; it developes slowly, but is a strong grower when it secures a good hold upon the soil. Mr. Gird's advice that the plant be not pastured the first year, because of the danger of uprooting it, is valuable. It is possible that it has been regarded a failure by some because of its destruction in this way. The *miliums* generally have rather a poor reputation for forage, but the *multiflorum* is, perhaps, the best of its kind in

*Report Coll. of Agr., University of California, 1879, p. 94.

this regard, and as its young growth comes at a time when the growth of more relished plants is retarded, it promises to be a valuable addition to our pastures. The following are extracts from correspondence on the growth of this plant:

W. A. McKaig, Little Stony, Colusa County.—The *Milium multiflorum* came up this year (1885) in February on dry land, and now (October fourteenth) is still green. It continued to grow in the heat of summer. It is quite defiant to drought and cold. It is, however, very difficult to get a good stand of it. Mr. McKaig wrote again, March 23, 1886: Our *Milium multiflorum* continues to do well.

H. H. Gird, Fallbrook, San Diego County.—Two years ago I scattered seed of the *Milium multiflorum* on the flats and hilltops, northern slopes and deep gulches, to take its chances with the native growths. It came up with the first rains, thrives, and spreads. I have found stools three hundred yards from where I sowed it. Evidently it will take care of itself, and spread over the ranch in time. It has come to stay. It shows green throughout the entire dry season on the hills, starts with the damp weather in the fall, and with the first rain grows vigorously. Ten days ago (November tenth) it furnished a full bite, which no native forage plant yet does. Though this grass has been condemned, I would not like to be deprived of it; and I think it will be found that the College of Agriculture has done a good work in distributing it. If sown on loose ground, stock should be kept away from it until the next winter rains shall settle the ground, or they may pull it up. If sown on stubble or hard ground, pasturing from the start does not hurt it, as it sets firm and tillers out instead of running up straight. Cattle eat it but little after the alfilerilla is well up, but that fact detracts but little from its value. It is excellent in its season. Those who object to certain plants may have failed to notice that many of our native plants are refused by stock in certain stages of their growth. Some are excellent when dry but refused when green, and *vice versa*. Our unequaled burr clover may be cited as an example. Alfilerilla, that *ne plus ultra* of forage plants, is relished both green and dry; first, last, and all the time.

J. F. Newland, Willows, Colusa County.—I gave some of the seed of *Milium multiflorum* to a man on the river. It grew about sixteen inches high, and now (October twentieth) is still green.

Martin Kirby, Darrah, Mariposa County.—I sowed *Milium multiflorum* two seasons, and could not see that a single seed germinated. The third season, however, I noticed a new growth spreading on the field, and it proved to be the milium. It grows and spreads with very little moisture (no irrigation), but in this respect is excelled by a brome grass which I think is the Hungarian brome received from the University, but am not sure. The time required for a grass to make itself known on dry soil, even if adapted to it, is more than a season or two.

L. B. Guill, Alturas, Modoc County.—The millet grass did not do very well. Very few seed came up. Some of the ground was kept damp, and other was dry. It did not seem to make any difference in the grass. The seed was raked in with a garden rake. Will try some on my meadow next season.

Samuel S. Baechtel, Little Valley, Mendocino County.—I sowed the *Milium multiflorum* broadcast. I could find only twelve or fourteen of the plants afterward, and each plant grew but a single seed stem about sixteen inches high. The plant seems delicate; it did not bear seed, but remained green until November. I gave it no irrigation. We have frost nearly every month in the year, and a northern exposure. The soil is cold, and oats does better than any other crop.

SNAIL CLOVER (*Medicago turbinata*).

This plant, indigenous to Southwestern Spain, has been grown and distributed with the hope that it might prove a valuable ally to its congener, *Medicago denticulata*, the well known and valuable plant "burr clover." The snail clover has the advantage of a smooth pod, which will not cling to the fleece of sheep or goats. The pod is globular, spirally round, and rather more than twice the diameter of that of burr clover. The seed is produced abundantly, and the ground is covered with the pods when the plant dies down in the dry season. The plant starts early with the rains and makes a dense mat of foliage. Its trial has not yet been sufficient in this State to demonstrate its character and quality, but the following notes from correspondents are of interest:

Gen. John Bidwell, Chico, Butte County.—I planted the seed of *Medicago turbinata* in my garden. It grew well and produced considerable seed, which, not all maturing at the same time, much of it was taken by the birds. Though the plant made a vigorous growth,

it has died even to the roots, which shows it to be an annual. Still I am hopeful that it will prove a valuable addition to our fodder plants in this dry, peculiar climate.

Mrs. L. S. Cleland, Mesa Grande, San Diego County.—I planted the snail clover very late in the spring, but it did well. I raised nearly half a grain sack of seed from the small package sent me. Cattle and horses are extremely fond of it. I shall plant the whole of the seed so as to get more for distribution in this vicinity.

N. J. Schultz, Brown's Valley, Yuba County.—The snail clover has done better than I anticipated. I sowed it on moderately rich soil. It made a luxuriant growth, and the ground was covered with pods. It is excellent sheep feed, but I do not think it will do as well as brome grass on poor soil. I will sow snail clover this fall on poor soil and see what it will do.

AUSTRALIAN SALT BUSHES (*Atriplex sp*).

The introduction of these plants to California was warmly advocated for some time by Dr. H. Behr, of San Francisco, and seed was obtained by him for propagation at the University. There are several species indigenous to Australia, and highly commended by Baron Von Mueller in his reports as Government Botanist of Victoria. Seed of two species was obtained by Dr. Behr, *Atriplex vesicarium* and *A. nummularium*. In propagation here, and in the experience of those to whom plants of both species were given out for trial, the *A. nummularium* seemed best adapted to California conditions, and in later distributions this species only has been sent out, though both have been kept in the garden of economic plants of the University. Of this species, Baron Von Mueller says:*

Atriplex nummularium, Lindley—From Queensland, through the desert tracts, to Victoria and South Australia. One of the tallest and most fattening and wholesome of Australian pastoral salt bushes, also highly recommended for artificial rearing, as the spontaneously growing plants, by close occupation of the sheep and cattle runs, have largely disappeared, and as this useful bush, even in wide tracts of Australia, does not exist.

The plantations of the salt bushes on the University grounds have done very well, the bushes spreading broadly and being full of leafy stems and evidently disposed to make a large amount of succulent herbage of a pleasant, saline flavor. We should consider it rather doubtful whether such plants would exert a desirable influence upon the flavor of milk secretion, but no complaint is made of it in this respect. With this, as with many other forage plants, there is a disagreement among different growers as to the relish of stock for the plant, and this must be attributed to the well known eccentricities of animal appetite. The plant seems to have considerable promise on desert areas and in soil moderately alkaline, as the experience given below shows that it does not like too strong a dose of these salts, and is not averse to good soil. The following notes are from reports of those who received plants from the University for trial:

F. Riley, Moro, San Luis Obispo County.—Planted two bushes in salt marsh, and one on sand dunes along the shore of Morro Bay. They all died. Seven plants planted on my farm and moderately watered made a seasonable growth. It seems to me rather a tender plant, and likely to be easily destroyed by stock.

S. G. Baker, Norwalk, Los Angeles County.—Some plants I set out in alkali soil, having by analysis 65 per cent salt and 11 per cent soda. They all died. Others I put in soil with about 30 per cent salt, and they lived. Some I planted in good soil in the shade of a tree for one year, and then transplanted to salt land. They do the best of all. I find horses, cattle, and sheep like it. Calves have a special liking for it and eat it with avidity. I consider it quite an acquisition to our forage plants, if fed in moderate quantity with other things, such as grass and hay. It is perennial and evergreen, and is easily propagated by layers. My largest bush is now three feet high and ten feet around.

H. H. Gird, Fallbrook, San Diego County.—The salt bushes I received two years ago form a dense growth six feet high. Cattle seem to relish the plant, but I do not know that they would care to live on it straight.

W. H. Crowley, Norwalk, Los Angeles County.—The salt bushes were planted along a

*Select Plants for Industrial Culture in Extra-Tropical Countries, page 38.

ditch where the cattle had free access to them, but they would not touch them. The plants were transplanted to alkali land of very strong salts and grew well, but I consider them of no value.

F. Riley, Morro, San Luis Obispo County.—I planted some of the salt bushes in salt grass land, and some in sand dunes, and some on good corn land. The plants died in the first two situations, but perhaps because of late planting. On corn land they did well and made bunches four and five feet in diameter. Cows eat the brush with great relish, and I think it a good forage plant. It seems to grow readily from cuttings, and I shall try them this year in the sand hills.

Kenyon Cox, Anaheim, Los Angeles County.—The salt bushes grow thriftily, but I have been unable to find any animal that will eat it. I have tried feeding it to horses, cows, sheep, and hogs, but all alike reject it.

The report of the College of Agriculture for 1882 cites the satisfactory experience of Mr. G. Shoof, of San Francisco, who tried the plant on salt marsh at Alvarado, Alameda County, and found that it would grow on land which would carry nothing but "salt grass," and that his stock was very fond of it.

SORGHUMS GROWN FOR FORAGE.

The growing interest in sorghum, as a plant for summer and fall food for milch cows, seemed to make desirable a sowing of a collection of the leading varieties in the market, both to test their comparative value and to give the many visitors to the University grounds an opportunity of examining their growth. The piece of ground selected had been used for cereals for a number of years. It is rather deficient in drainage, and could not be worked until quite late in the season, and even then was not brought into very good tilth. The seed of seven varieties of sorghum was obtained at the East, and was sown in drills three feet apart, May 5, 1886. A good stand was obtained, but the plants grew rather slowly at first. As the weather became warmer the growth was accelerated, and the collection made a very good showing for our climate, which is too cool for the best results with plants of this family. No irrigation was given. Portions of each plat were cut in different stages of growth, and the results of the weighings are given in the following table:

WEIGHTS OF SORGHUM—VARIETIES CUT AT DIFFERENT STAGES OF GROWTH.

Variety.	First Cutting, Before Heading Out. Aug. 10. Pounds per Acre.		Second Cutting, "in the Milk." Sept. 10. Pounds per Acre.		Third Cutting, "in the Dough." Sept. 29. Pounds per Acre.		Average Height of Plant at Maturity.
	Green.	Dried.	Green.	Dried.	Green.	Dried.	
Honduras	27,985	8,700	41,470	17,690	43,790	17,690	7½ feet.
Stewart's hybrid	31,320	11,600	44,950	21,750	43,500	21,750	8 feet.
Rural branching	13,050	4,541	23,490	9,280	24,650	9,280	5 feet.
Chinese imphee	31,030	10,150	37,700	15,950	45,530	23,780	8½ feet.
Early orange	22,330	10,440	38,670	15,080	49,010	20,010	8 feet.
Early amber	25,520	7,830	49,590	17,400	60,320	23,200	8½ feet.
Kaffir corn	15,370	4,930	18,850	7,850	17,400	5,740	4½ feet.

Second growths started quickly after each of the cuttings noted above, and a very fine growth was made without application of water. In some cases the second growths headed out, but the proportion of leaf to stem was much greater than in the first growth. The following weighings were made of second crops:

YIELDS PER ACRE OF SECOND GROWTHS OF SORGHUMS.

Variety.	Second Cutting, Nov. 22, of Plat Cut Aug. 10. Lbs. per Acre.	Second Cutting, Dec. 10, of Plat Cut Sept. 10. Lbs. per Acre.	Pounds per Acre for Two Cuttings.	
			Aug. and Nov.	Sept. and Dec.
Honduras	17,800	3,204	45,785	44,674
Stewart's hybrid	15,664	5,340	46,984	50,290
Rural branching	9,612	1,424	22,662	24,914
Chinese imphee	22,072	4,628	53,102	42,328
Early orange	14,952	1,958	37,286	40,628
Early amber	14,240	2,848	39,760	52,438
Kaffir corn	12,104	3,204	27,474	22,054

The above are all weights of green fodder, immediately after cutting. The columns which combine the two cuttings from the same plants at different dates, contain interesting data, and indicate that one must study the growth of the varieties carefully to secure two cuttings of maximum amount, and that the ratio between the cuttings at fixed dates is not constant. For example, the highest result with Chinese Imphee was gained by cutting in August and November, while with the Early Amber there was more weight secured by cutting in September and December. The full significance of the results noted in the last two columns of the last table can only be understood by gaining more light from future experiments.

Feeding experiments carried on to test the preference of cows for either of the varieties named above showed that the Chinese Imphee was eaten fully, while of all the other varieties there were butts of the cane left, from a foot to eighteen inches in length.

Another plant, grown in the same plot, but not weighed because of its slower growth, was the Pearl millet *(Penicillaria spicata)*, which has been mentioned in previous reports of this institution. It made a very good growth of blade and stem, and a large crop of heads. The cattle were very fond of it, and ate it up clean, the green seed heads as well as the leaves and stems.

The plant named Kaffir corn was grown from seed donated by Dr. J. H. Watkins, of Palmetto, Georgia. It is a member of the sorghum family, bearing a seed resembling the white dhoura, or Egyptian corn. The plant is, however, of different habit, bearing its seed stem erect, and being generally of a more stocky growth. It proved with us of slower development than the other sorghums mentioned in the table above; but its growth late in the season, as shown by the table of second cuttings, was very creditable, surpassing in this respect the "Rural Branching Sorghum" or "Millo maize," as it is generally called at the South. A superiority which is claimed for the Kaffir corn at the South is that it sends but one stem from the ground (thus leaving a stubble, which is easily handled), and branches freely at the top. In our experiment it stooled out somewhat, and also showed a disposition to branch at the top. The growth, after cutting, was very good. The table above shows its second growth heavier than some of the tall sorghums. The grain is very large and fine, and was borne in larger amount than is usual for the sorghum family in this location. The variety certainly seems worthy of trial beside the common Egyptian corn in those parts of the State where the latter yields well, and is becoming popular as a grain and forage plant. We receive many notes of the successful substitution of Egyptian corn as a substitute for barley for horses, and wheat for chicken feed.

TAGASASTE.

Tagasaste *(Cytisus proliferus albus):* A species of broom; a bush-like plant, recommended by the American Consul at the Azores Islands as a valuable forage plant for dry hill lands. Small packages of the seed of this plant were distributed last year, but reports of its growth or value have not yet come in. In the garden of economic plants it has grown to a shrub-like form and attained a height of six to nine feet. An abundance of beautiful white flowers resembling those of the locust appeared in December, and it is probable that seed will be gathered this season. When grown in a drier situation it would show the characteristic form on the Azores Islands, being lower and more spreading, especially when browsed by stock. We have failed to induce the village cows to eat it when the branches are cut and placed before them. Possibly less pampered horned stock and goats would take more kindly to it. Baron Von Mueller in his "Select Plants"* says of it: "This tall herb is recommended as a fodder plant in countries exposed to drought." We shall endeavor during the coming season to secure fuller data concerning its growth and value in this State.

FLORA OF THE MOUNTAIN PASTURES OF CALIFORNIA.

There is a district including the meadows and pasture lands high up in the Sierra Nevada Mountains which, because of its climate and abundance of cool water from melting snows, differs in a marked degree from the other geographical divisions of the State, and has for years harbored a dairy interest of considerable proportions. With the idea of beginning a study of this region from a practical point of view, a request was made for specimens of the grasses which were recognized by the dairymen as furnishing the greater amounts of their pasture and meadow growths. There is a close resemblance between the geographical and climatic conditions of this Sierra region and that of the famous Alpine dairy region in Switzerland, and as the latter has been carefully studied and its agricultural characteristics set forth, it will be interesting to secure facts concerning our own Alpine district for comparison. As a contribution toward that result we give below the botanical determination by Mr. E. L. Greene, Assistant Professor of Botany in the University, of a group of specimens sent from Sierra County by Mr. G. W. Freeman. The notes of local names of the plants and the uses made of them are by Mr. Freeman:

GRASSES SENT FROM SIERRA COUNTY, BY G. W. FREEMAN.

No. 1. *Atropis Californica,* Munro.—"Bunch grass." This forms the greater part of the upland hay. Under favorable circumstances it grows from two to three and one half feet high.

No. 2. *Elymus triticoides,* Nutt.—"Bluejoint grass." It grows to about the same height as the "bunch grass." It forms but a small part of the upland hay crop in Sierra Valley, but grows in large quantities in the Truckee Valley. All ground which has been plowed and allowed to lie fallow here grows up with this grass.

No. 3. *Hordeum jubatum,* Linn.—"Wild timothy." It grows from three to four feet high and stands next to "bunch grass" in quantity in the upland hay.

No. 4. *Elymus triticoides,* Nutt.—"Wild rye." It grows from three to four feet high, in clumps, and is valuable as fall and winter pasturage. When the seed is scattered thickly over the ground, and is cut often, it makes a fair quality of hay, though not used much for that purpose.

No. 5. *Carex filifolia,* Nutt.—"Buffalo grass" (not of the plains). It makes the best pasture we have here. It forms a close, compact sod. It is strictly an upland grass. It never grows higher than six inches. Some years it seeds as early as April first, and dries up by the middle of June or first of July.

* Page 93.

No. 6. *Carix angustata*, Boott.—"Sour grass" or "self-rising" grows from two to three feet high. It is a swamp grass and forms about one fourth of the swamp hay.

No. 7. *Carex muricata*, Linn.—"Swamp grass." This grass forms seven eighths of the hay on the boggiest ground, and is not considered of much nutritive value.

No. 8. *Reckmannia crucæformis*, Host.—"Swamp millet." It grows from two to three and one half feet high. It does not occur in very large quantities. It is used for hay.

No. 9. *Descpampsia cæspitosa*, Beauv.—"Redtop," whether wild or introduced, is uncertain, as the seed of the tame "redtop" has been introduced and widely scattered over the swamp meadows. [This species is surely indigenous. E. L. G.]

No. 10. *Juncus breweri*, Engelm.—"Upland wire grass." A very nutritious grass; very valuable as pasturage, and when properly irrigated makes good hay, growing from eighteen to thirty inches high.

No. 11. *Juncus dubius*, Engelm.—"Swamp grass," with no distinctive local name; forms a large part of the lowland hay.

No. 12. *Juncus falcatus*, Meyer.—"Swamp grass," also having no local name; grows on the small knolls in the swampy ground.

No. 13. *Juncus Balticus*, Dethard.—"Lowland wire grass," sometimes called "tule grass;" it grows from three to four feet high, and forms a considerable part of the lowland hay.

There are doubtless other grasses worthy of enumeration, but the above are the chief ones which grow in large quantities enough to figure largely in the hay crop.

The large occurrence of species of Carex (sedges) and of Juncus (rushes) would not lead to a very high opinion of the herbage in which these occupied such a prominent place. No doubt, as the writer says, there are other better plants which act a good part in the meadow and pasture growth. It should be the effort of the land owners to introduce better grasses, adapted to the region, and in this work we shall be glad to render all possible service.

EXPERIMENTAL PLOTS IN THE GARDEN OF ECONOMIC PLANTS.

For the purposes of testing all grasses and forage plants which may possibly prove of value to the State, to preserve a collection of such growths for illustration and instruction, to afford means of comparison, and to secure seed for distribution and exchange, a considerable space in the garden of economic plants is devoted to small plots of grasses, clovers, etc. The following is a list of these plants thus grown, in December, 1886, and the collection will be extended as seeds are obtained:

GRAMINEÆ (GRASSES).

Hungarian Brome grass, *Bromus inermis;* S. Europe.
Schrader's Brome grass, *Bromus unioloides.*
Orchard grass, *Dactylis glomerata;* Europe.
Australian Rye grass, *Lolium perenne.*
Millet grass, *Milium multiflorum.*
Evergreen millet, *Sorghum halepense;* Old World.
Timothy, *Phleum pratense;* Europe.
"Rye grass" of Oregon and Washington, *Elymus condensatus.*
Kentucky Blue grass, *Poa pratensis.*
Soft Meadow grass, *Holcus lanatus;* Europe.
Red Top, *Agostis vulgaris;* Europe.
Italian Rye grass, *Lolium Italicum.*
Fall Oat grass, *Avena elatior;* Europe.
Panic grasses, *Panicum bulbosum;* Arizona; and *Panicum altissimum.*
Bermuda grass, *Cynodon dactylon;* Europe.
Paspalum ovatum (Texas?); *P. dilalatum; P. platicaule.*
Melica altissima.
Indian grass, or Wood grass, *Sorghum Nutans.*
Small Fescue, *Festuca tenuifolia;* America.
Roughish Meadow grass, *Poa trivialis;* Europe.
Sheep's Fescue, *Festuca ovina.*
Hard Fescue, *Festuca duriuscula;* N. America and Europe.
White Bent grass, *Agrostis alba;* Europe.
Grama grass, *Bouteloua aligostachya;* Colorado.
Large panicled Vilfa, *Sporobolus cryptandus.*
Indian Millet, *Ericoma cuspidata.*

Bunch grass, or Mountain Fescue, *Festuca gracillima.*
Fall Bunch grass, or Western Fescue, *Festuca Scabrella;* Oregon and Washington.
Bomus Sp.; Colorado.
Sucksdorf Brome grass, *Bromus Sucksdorfii.*
Agropyrum and *Elymus* mixed.
Mountain Timothy, *Phelum sp.;* Colorado.
Kangaroo grass, *Anthistiria ciliata;* Australia.
Soft Brome grass, *Bromus mollis;* Europe.
Elymus cristata.
Canary grass, *Phalaris Canariensis;* Europe.
Various-leaved Fescue grass, *Festuca heterophylla;* Europe.
Nit grass, *Gastridium Australe;* Pacific Coast and Europe.
Northwestern Blue grass, *Poa Nevadensis.*
Blue stem grass, *Agropyrum glaucum;* Colorado.
Feather bunch grass, *Stipa viridula.*
Mountain Blue joint, *Dryenxia.*
Bunch grass, *Agropyrum divergens;* Oregon and Washington Mountains.

LEGUMINOUS PLANTS (CLOVERS).

Yellow trefoil, *Medicago lupulina;* Europe.
Red clover, *Trifolium pratensis;* Europe.
Scarlet clover, *Trifolium incarnatum;* Europe.
Swedish clover, *Trifolium hybridum;* N. Europe.
Japan clover, *Lespideza striata;* E. Asia.
Common sainfoin, *Onobrychis sativa;* Europe.
Alfalfa, *Medicago sativa;* Old World.
White melilot or Bokhara clover, *Melilotus alba;* Old World.
Strawberry clover, *Trifolium pragiferum;* Europe.
Hairy vetch, *Vicia vilosa;* Germany,
Seradella, *Orithopus sativus;* Europe.
Sylla, *Hedysarum coronarum;* S. Europe.
Horned pod clover, *Anthyllis vulnaria;* Europe.
California clovers, *Trifolium involucratum* and *T. tridentatum.*

REPORT ON RESULTS OF DISTRIBUTION OF CEREALS.

One of the earliest efforts of the present administration of the College of Agriculture was to secure as full a collection as possible of the leading varieties of cereal grains from the different grain growing regions of the world. This work was in a large measure intrusted to my predecessor, Mr. C. H. Dwinelle, and was carried forward with much zeal and success. The objects of making such a collection were several, the most important of which were the securing of material for use in the instruction given on the growing of cereal crops, and the use of the seed thus obtained in the culture experiments which have been carried on. Although California has a world-wide fame as a grain country, there have always been districts in which loss has been occasionally sustained from rust, from insects, or from apparent ill-adaptation of the varieties sown, to the prevailing local conditions. There has also been constant improvement in the hardiness and fruitfulness of grains, secured by the systematic experiment or by the selection which are being conducted by enterprising men and by careful students in all parts of the world. The University collection, which at this time embraces upwards of two hundred and fifty named varieties of cereals, includes the results of this progressive work, and makes them available to the grain growers of the State. Public attention has been called to this important possession by well arranged exhibits of the State fairs and the fairs of the Mechanics' Institute, and an important service has been rendered by familiarizing the people with the chief forms and characteristics of the cereals as grown for food in all parts of the world.

The reports of the College of Agriculture since 1879, contain allusions

to the character and quality of the grains forming this collection and reports of comparative tests of their growth and productiveness on the experimental grounds of the University. Those varieties which have given best results in these tests have been distributed to various parts of the State. Reports from those who received the seed for trial have not been as fully rendered as we desired, and yet enough have been received to furnish important data as to the comparative value and the special adaptations of quite a number of varieties. A condensed statement of these results, in connection with brief notes of the origin of the variety, will be given herewith:

I. Barleys.

SIX-ROWED BARLEY.

This barley is of quite a different type from that commonly grown in this State. The arrangement of the grains in the head is such as to show six distinct rows, instead of the crowded appearance which makes our common barley pass as four-rowed. The straw is of only moderate length, strong, and very erect, making it less liable to lodge than most other varieties. The heavy rains of June, 1884, which prostrated nearly all the other grains on our grounds, did not affect this variety. It stood erect and strong. The yield is among the highest that we have recorded in our experiments. Our stock was raised from seed secured in the Brenner collection, imported from Europe, where the grain is also particularly valued for mountain lands.

In distributing the seed of this variety it was stated that we especially recommended it for trial in the northern valleys of the State. The experience cited below shows that this probability of its adaptation was well discerned, and that it is illy adapted for the southern coast regions. We give the following extracts from correspondence:

W. H. Nelson, Marysville, Yuba County.—The six-rowed barley was sown March fourth and received no rain nor irrigation. It grew steadily, and ripened about the same time as summer fallow wheat. The yield was large. Veteran farmers of this district consider it a very promising variety.

John R. Norris, Santa Maria, Santa Barbara County.—Six-rowed barley, sown on rich, black, sandy loam, came up, but failed to head. If sown in damp land I think it would produce a large crop, as it is inclined to spread wonderfully, and were it not for its spreading quality I think it would do better on dry soil.

Phil. Hope, Coulterville, Mariposa County.—Six-rowed barley sown January 20, 1885, on red loam, came up well and made a wonderful growth, yielding a splendid grain. It is the strongest growing barley that I have ever seen.

Peter Davis, Santa Barbara.—I sowed the six-rowed barley on good land after a vegetable crop, in January, which is the best time for sowing barley here. It grew about two feet high, but had no grain in the heads. The "Rice" or "Battledore" barley did a little better, but the grain was very light. These varieties do not seem suited to this part of the country.

J. W. Short, Polonia Ranch, Kern County.—I am satisfied that the six-rowed barley will make much better hay than the common bearded kind, as it produces more blades and less stalk.

BALD BARLEY.

The Nepaul or bald barley has become generally well known throughout the central portion of the State, at least as an excellent variety for hay. The freedom from beards is a great advantage, and the abundant leaf growth makes a tender and desirable hay grain. The same characteristic makes it excellent for soiling. The chief objection to the variety is that it shows signs of lacking hardiness and is rather more subject to rust and aphis than some other sorts. Both the good and bad points are brought out in the following extracts from correspondents:

John Talbert, Montezuma Hills, Collinsville, Solano County.—I sowed the one pound of Nepaul barley on hilly adobe soil, on February 19, 1885. After sowing but one slight shower fell. Only about half the seed germinated, because of the drought, and yet what did come up grew well and produced well, there being seventy-five pounds of clear grain. It stooled from fifteen to twenty-five heads from one grain, and there were an average of ninety-five grains to the head in ten heads that I counted. According to my experience, it should be sown about forty pounds to the acre. This year (1886) I sowed the seventy-five pounds of seed on about two acres of the same hilly adobe soil and it yielded twenty-three sacks of one hundred and fifty pounds each, and there were fully twenty sacks scattered on the ground before it was gathered. I think it will be most profitable for hay. I find the grain I gathered is much brighter than the seed you sent me and which was grown in Berkeley. I am satisfied that it will prove valuable.

Hugh Matthews, Emmet, San Joaquin County.—The Nepaul barley came up finely, and grew well, making large stools and bearing large heads. Just as the plants were in blossom they were attacked by insects, which exhausted the plant and prevented the heads from filling. I thing it will make splendid hay, as there are so many blades to the stalk. I will try it further.

T. W. Dashiel, Potter Valley, Mendocino County.—I do not like the Nepaul barley, as the grain seems to be too hard for stock unless soaked.

Phil. Hope, Coulterville, Mariposa County.—Nepaul barley, sowed February fifteenth upon gravelly loam, came up at once and made a vigorous growth. It is well adapted for this section. Our elevation is one thousand six hundred and fifty feet.

H. Beaver, Guerneville, Sonoma County.—A late frost killed the Nepaul barley.

H. H. Nunnally, Etna, Siskiyou County.—The Nepaul barley seems to be at home in this county.

B. C. Wright, Hopland, Mendocino County.—The bald barley makes most excellent hay, and gives a good yield. The stalk is soft and full of leaves.

George Meding, Buckeye, Shasta County.—I believe the Nepaul barley is the best kind to sow for hay for any kind of stock, because it has so many leaves, and is far better than the common barley.

James Askew, El Dorado.—Nepaul barley, irrigated once a week. It grew, on an average, eighteen inches high, rusted somewhat, but made plump grain. It does not grow high enough here for hay. I sowed it in March; it might do better if sown earlier.

M. C. Woodson, San Diego.—The bald barley grew very rank, and looked very promising until it was stricken by rust so badly that the heads all blighted.

W. Pfortner, San Andreas, Calaveras County.—I grew thirty pounds of bald barley from fourteen ounces of seed. It grows very vigorously, and I think will be valuable for hay, as the stem has leaves all along from the ground up. I consider the grain quite an acquisition.

A. H. Bradford, Rohnerville, Humboldt County.—Bald barley sown April fourth on rich sandy loam started well but when six inches high was so attacked by the grain aphis that it was nearly destroyed, recovering only enough to return about as much seed as was sown.

John Beaumont, Dark Cañon, Humboldt County.—I think the bald barley is well suited for hay in our hills. A farmer who has grown it for several years sells the hay to a livery stableman and says they esteem it highly for its good qualities and the fondness of stock for it.

FRICK'S DROUGHT-PROOF BARLEY.

This variety originated in Washington Township, Alameda County, California. Ernest H. Frick found, in 1869, two heads in his field of Chevalier growing a foot higher than the average of the crop, the heads erect while the Chevalier lopped down, and the color of the two heads being of a noticeably bright golden color. He plucked the heads, gave the grain garden culture, and when enough seed was obtained sowed a field of it. In 1874 he sowed the new variety alongside Chevalier, and in the severe drought of that year which caused all dry-soil crops to fail, the new grain grew well and matured a good crop. Mr. Frick furnished the College of Agriculture the seed of his new variety in 1879, and a full statement of his experience and claims for the grain may be found in the report of this institution for that year. The barley was grown on the experimental grounds and seed distributed, from which the following reports were received:

W. A. McKaig.—Little Stony, Colusa County.—Frick's "drought-proof" barley was sown in February, in a field of common barley, and was treated in all respects the same. Hardly any rain fell after the grains were sown. Growing side by side it was quite apparent that in this locality the new barley was a failure. In length of straw, in productiveness of seed, and ability to stand drought, it was inferior to the common barley.

L. Jared, San Miguel, San Luis Obispo County.—Frick's barley did reasonably well, being a little earlier than Chevalier. The yield was not above that of common barley. It did not fill well, doubtless owing to a partial drought.

John R. Norris, Santa Maria, Santa Barbara County.—Frick's barley was sown alongside the six-rowed, and at the same time. It grew about three feet high, with fine long heads well filled, and certainly bore at the rate of fifty centals per acre. I have raised most all of the different varieties of barley, but this is the finest I have ever seen, both as to quantity and quality. It stands up, fills well, and stands drought. It had no rain after planting.

Phil. Hope, Coulterville, Mariposa County.—Frick's barley, sowed February fifteenth, on gravelly loam, made a good growth; straw short and fine, carrying the finest barley that I have ever seen. It yields enormously.

W. H. Mullen, Big Bend, Butte County.—Frick's "drought-proof" barley, I believe, is a good barley for dry soils. It did well with me last year. I think it will prove just the thing for our dry hill land. My place is near the top of a ridge, about one thousand eight hundred feet elevation, and sloping to the south.

BLUE BARLEY.

This plant has shown value for green feeding, and the grain has won esteem for animal food, though its hard, smooth kernel will probably have to be cracked to give best results, except with poultry. It is quite new to this State, and for this reason it may take time for millers and feed grain dealers to become acquainted with it. The grain loses its chaff in thrashing, is dark blue or purple, and the stem and foliage partake of the same color while growing. The following are reports concerning its growth in different parts of the State:

William Jones, Jr., Lincoln, Placer County.—The blue barley I received from you grew finely and yielded well. Being early in maturing it just escaped the grasshoppers, which did such injury in this vicinity about June 1 (1885). I can't find out what the blue barley is good for; I have taken it to millers, and they had never seen it before. I propose to continue growing it, as it does well here and I think it will make good feed for horses.

C. Schofield, San José.—The blue barley grows and yields well, but I do not like it because of the heavy beards and flinty grain.

Robert Doran, Porterville, Tulare County.—The blue, smooth barley stands drought better than any grain I ever saw. The quality was good and the yield large. I cannot tell the value of the grain, but it is good for poultry, and if hogs can get to it when it is green and growing, they will leave common barley for the blue.

H. Beaver, Guerneville, Sonoma County.—The blue barley gave a fair crop, but rusted somewhat.

W. H. Mullen, Big Bend, Butte County.—The black barley did not amount to anything.

N. B. Rine, Alturas, Modoc County.—I sowed the blue barley on sage brush land, a sandy loam with some alkali. I never saw anything outyield the blue barley, although it was cut down once by the crickets.

James Malone, Independence, Inyo County.—The blue barley is a very productive crop here. We have to irrigate all grain crops.

COMPARATIVE YIELDS OF BARLEY VARIETIES IN SAN JOAQUIN COUNTY.

George S. Locke of Lockeford, San Joaquin County, reports the comparative yields of barley varieties sent him in the spring of 1885. The barley was all sown very late on sandy upland along the bluff of the Mokelumne River, and had no rain after sowing:

Variety.	Amount Sown—lbs.	Crop—lbs.
Napaul or bald barley	1	8
Bluish barley	1	11½
Imperial two-rowed barley	1	11
Frick's drought-proof barley	1	7½
Rice barley	1	Entire failure.
Brenner's six-rowed barley	1	Nearly failure.
Carter's prolific barley	1	11
Scotch two-rowed barley	1	10

BRIEF NOTES ON OTHER VARIETIES.

Reports on several other varieties of barley sent out for experiment are too meager to warrant generalization of results. The following notes are introduced from the few letters received:

William Haddox, El Monte, Los Angeles County.—Imperial two-rowed barley, sown February 22, 1884, came up nicely and grew well until the very heavy rains caused the water to rise in the soil, and nearly killed it, but I hope to get a little seed. It was, however, so late in heading that all other barley in the vicinity had been cut for hay, and the blackbirds took all the grain while it was in the milk.

J. M. Berry, Wheatland, Yuba County.—The Scotch two-rowed barley grew well, but was inclined to lodge.

E. A. Irish, Christine, Mendocino County.—If the Scotch two-rowed does not do better on later trials I shall pronounce it not worth growing in this county.

Robert Doran, Porterville, Tulare County.—The Scotch two-rowed does not stand drought as well as common barley.

Otto Wyss, Adelaida, San Luis Obispo County.—The Scotch barley gives a very plump grain of the best color. It is fuller and plumper than any common barley grown about here.

H. Beaver, Guerneville, Sonoma County.—Carter's Prolific barley gave a good yield. It is a good grain for hay.

II. Wheats.

DEFIANCE (PRINGLE'S HYBRID).

One of the earliest efforts aimed at in the distribution of wheat varieties was to secure for those parts of the State where wheat growing was very precarious, because of the injury by rust. Several varieties obtained from different parts of the world, claimed to be rust proof, were obtained and distributed, and the result has shown that resistance of certain sorts may be trusted, and wheat growing in regions subject to rust has, therefore, become a trustworthy undertaking. The most generally satisfactory grain is Pringle's Defiance, a hybrid of a white wheat common in California, upon an eastern club variety, which originated in Vermont and was distributed by B. K. Bliss & Sons, at one dollar per pound, about 1877. A supply of the seed was donated to the University in September, 1879, by Claude V. Burke, of Yolo County, and the grain grown from it was afterwards distributed to applicants in different parts of the State. The following reports show the values found in it by different growers:

John Newlon, Santa Maria, Santa Barbara County.—Genesee wheat rusted and was worthless beside the Defiance, which made a crop. Defiance should be sown early.

G. S. Reuter, Sonora, Tuolumne County.—The Defiance wheat yielded well, some heads being seven inches in length and had ninety-four kernels.

H. H. Nunnally, Etna, Siskiyou County.—All my other wheats rusted badly, but there was not a speck of rust on the Defiance.

J. F. Eutler, Chico, Butte County.—The Defiance wheat is of good quality and does not rust.

E. A. Irish, Christine, Mendocino County.—The Defiance yielded a little more than twice as much as our common wheats and showed no sign of rust. It is the best wheat I ever saw.

E. A. May, Woodville, Tulare County.—I believe that in this valley the Defiance is without value except where it can be irrigated, and with irrigation it would surpass in yield all other varieties now grown. It stands up well and does not shatter out, but it requires more moisture than Sonora or Proper.

J. B. Freed, Gonzales, Monterey County.—Defiance wheat was clear and healthy while white Australian was rusty and Proper was both rusty and smutty.

Mrs. C. Pagani, Mayfield, San Mateo County.—I did not report last year (1884) because I was not sure that the Defiance wheat you sent me was rust proof, but I have proved it this year. It did not have a sign of rust, while all the other grain was killed by rust. The wheat is very fine; I am proud of it.

G. W. Faulkner, Santa Paula, Ventura County.—The Defiance is the finest headed wheat I ever saw and is entirely free from rust. My neighbors indorsed my opinion of it.

C. O. Tucker, Ballena, San Diego County.—The results of my experiments convince me

that Defiance is certainly rust proof, and under adverse conditions will yield a good crop. I have this year tested red and white Sonora, Odessa, Touzelle, Pride of Butte, Proper, and Snowflake under precisely the same conditions as the Defiance, and they all succumbed to the rust.

Milo Carey, Nordhoff, Ventura County.—The Defiance wheat yields well and is a good wheat.

VARIOUS OTHER WHEATS.

Of the large numbers of wheats in the University collection many samples have been sent out to applicants, but comparatively few have reported results. We give below a group of notes which are of value to those experimenting in the different localities named, but do not furnish data for general conclusions as to the adaptations of the varieties:

John Lowe, Janesville, Lassen County.—The Egyptian wheat sown in the garden at the usual time for sowing spring wheat, made a fine growth of straw and a pretty good yield of grain, but a little dark in color and shrunken—perhaps from growing too thickly. After cutting, leaf growth started again on the stubble, from which I conclude that the grain should have had a longer growing season. The wheat was wholly free from smut, though I used no bluestone or other preventive.

A. P. Chapman, Sierra Valley, Sierra County.—The Polish wheat sown April twenty-seventh, and watered three times, grew five feet high, with heads nine inches. It was hurt by heavy frosts in August, but made a small yield. I will try it again on higher ground without irrigation. I have had the grain before. I consider it the best chicken feed I ever used—worth more than other wheats for that purpose.

Phil. Hope, Coulterville, Mariposa County.—Black-Bearded Centennial wheat made a splendid growth, but was destroyed by grasshoppers after it was well headed.

James Malone, Independence, Inyo County.—The Centennial requires too long a season to do well here, and the straw is so heavy that it will hold up the blackbirds which alight upon it and take every kernel out of its large full head.

Phil. Hope, Coulterville, Mariposa County.—Paine's Defiance wheat, sown February fifteenth on gravelly loam, did not head at all, but stooled out well, bearing abundant blades of a beautiful deep red color. It seemed to me from its growth that it needed much earlier sowing.

James Asberry, El Dorado.—I am of the opinion that Paine's Defiance wheat is a good wheat to sow early, for it kept stooling out until I was through cutting other grain. Mine was sown too late to reach a good result.

J. W. Short, Polonia Ranch, Kern County.—I am satisfied that Hallett's Pedigree wheat in this climate is a failure.

T. W. Dashiel, Potter Valley, Mendocino County.—I consider the Whittington wheat an excellent variety, and think it will do well in this part of the country.

James Malone, Independence, Inyo County.—The Snowflake is the best spring wheat I have grown, both in yield and quality. We have no rust here.

Phil. Hope, Coulterville, Mariposa County.—Australian wheat, sown February fifteenth, upon gravelly loam, made an immense growth; but was stricken with rust when heading out, and was totally destroyed.

GRAIN TESTS ON RANCHO CHICO.

Hon. John Bidwell, of Rancho Chico, has done much to extend knowledge of the adaptations of the upper portion of the Sacramento Valley by the careful experimental work which he has conducted. We have been fortunate in placing in his hands for trial for several years supplies of the seeds we desired to have tested, and his reports have been of much value in our work. We present herewith extracts from General Bidwell's reports to the College of Agriculture, for 1882 and 1886. On January 26, 1882, he wrote as follows:

Each of the samples of grains weighed about one pound, and was sown on three square rods of ground, February 8, 1881. The soil, though alluvium, was very dry, being above all overflows. It was not of the richest nor poorest, but a fair average, perhaps, of wheat lands in this part of the State, and would be called rather sandy or gravelly loam.

Such land often has the effect on early sowing of producing heavy straw and causing the grain to lodge, especially in seasons of abundant rain such as 1881. Hence the delay in sowing till February.

The said samples consisted of (wheat) Clawson, Snowflake, Odessa, Atlanti Greek, Black Bearded Centennial, and Black Bearded Macaroni; (barley) Blue Smooth or bald barley, Scotch two-rowed barley, and black two-rowed barley.

The Clawson came to nothing—scarcely headed out. That is evidently a kind of wheat which requires a long time to grow, and, therefore, should be sown in this climate, early—say in November or, at the latest, in December.

The yield of the others was as follows:

	Pounds.	Rate per Acre about —bushels.
Snowflake wheat	25	22
Odessa wheat	33	29
Atlanti Greek wheat	38	34
Black Bearded Centennial wheat	36	32
Black Bearded Macaroni wheat	22	20
Blue Smooth barley	23	25
Scotch two-rowed barley	41	44
Black two-rowed barley	30	30

The bushels are estimated on the basis of sixty pounds for wheat and fifty pounds for barley. The figures are within rather than above a correct statement, sample sheaves having been taken before thrashing for our State and District Fairs.

The full page table appended gives the results of experiments with thirty-two wheats and barleys. As Gen. Bidwell has experience both in milling and grain growing, his remarks upon the different varieties possess a double value.

KINDS OF GRAIN.	DATES—1885.		Yield per Acre. (Estimated.) Pounds.	REMARKS.
	SOWN.	HARVESTED.		
Palestine wheat	January 30	July 5	1,460	Bearded, straw short, early; worthy of further trial.
Pringle's Best wheat	January 30	June 23	1,645	Stood well, grain plump; worthy of further trial.
"Fern or April wheat"	January 30	June 23	1,325	Bearded, well-filled head; worthy of further trial.
Volo wheat	January 30	June 23	1,490	Straw slender, early, grain good, short head, and very long beard; worthy of further trial.
Square Sicilian wheat	January 30	June 23	740	Red, early, short head, grain small, yield light.
Red Club wheat	January 30	June 23	1,345	Head short, stands well, yield fair; worthy of further trial.
"Rye wheat"	January 30	June 23	1,350	Tall, straight straw, red grain, and somewhat shrunk; worthy further trial.
"Willington" wheat	January 30	June 23	650	Stands well, grain small, poor yield.
California Spring wheat	January 30	June 23	1,725	White, fine head, plump grain, stands well; very promising.
Pringle's Defiance wheat	January 30	June 23	1,660	Tall, but stands well; fine white grain; very promising.
Michigan Mixed wheat	January 30	June 23	750	Small, red chaff, white grain; yield poor, but thought worthy further trial.
White Australian wheat	January 30	June 23	1,465	Straw short, good head, white plump grain; thought worthy further trial.
Yellow Noe wheat	January 30	July 10	1,475	Red, grain good, late, stands well, head rather small; worthy further trial.
White Flanders wheat	January 30	July 10		Short, small, very poor, very late; not recommended.
Chiddam wheat	January 30	July 10		Short, small, very poor, very late; not recommended.
Hallett's Original wheat	January 30	July 25		Short, small, very poor, very late; not recommended.
Spalding's Prolific wheat	January 30	July 25		Came to nothing; not recommended.
Blood Red wheat	January 30	July 25		Came to nothing; not recommended.
Hallett's Pedigree wheat	January 30	July 25	855	Straw short, head small, late; give it another trial.
White Essex wheat	January 30	July 25		Thin, not promising; not recommended.
Smogge wheat	January 30	July 25		Total failure; not recommended.
Silsby No. 1 wheat	January 30	Total failure.		
Paine's Defiance wheat	January 30	July 25		Latest of all; straw slender, head large, grain good; worthy of further trial, on thin land, or medium.
Large, bald, two-rowed barley	January 30	May 27	1,525	Very early; straw short, good head, yield fair; further trial suggested.
Black two-rowed barley	January 30	May 27	1,545	Earliest of all; straw short, head and yield good; further trial suggested.
Guamalaya barley	January 30	June 8	1,515	Bald, straw short, good head and yield; further trial suggested.
Rice barley	January 30	June 23	715	Flat, two-rowed head; straw short, poor yield; not recommended.
Frick's barley	January 30	June 23	700	Two-rowed, very thin, grain good, poor yield; not recommended.
Carter's Prolific, two-rowed	January 30	June 23	1,476	Straw short, head long and drooping, yield fair; will try again.
Imperial, four-rowed barley	January 30	June 23	685	Straw and head short, grain small, yield poor; not recommended.
Six-rowed (No. 1) barley	January 30	July 5		Late, small, bad yield; not recommended.
Six-rowed (No. 2) barley	January 30	July 25		Late, small, bad yield; not recommended.

NOTE.—The soil (a dry, sandy loam,) was of only medium fertility. Could the unusually dry winter and spring have been foreseen, the sowing would have been earlier. On account of the late sowing, therefore, the trials made, both of wheat and barley, are necessarily imperfect. Those samples which have proved failures, might have resulted far otherwise had the sowing been early or the season one of abundant moisture.

JOHN BIDWELL, Chico, Butte County.

ST. JOHN'S DAY RYE.

St. John's Day rye was imported from Germany by the University as one of the best known ryes. As grown on the experimental grounds it had heavy, drooping heads, broad near the stem and tapering toward the tip. The beards are many and fine. As the following reports show, the variety promises to prove of value to our mountain farmers:

George Behrus, Garden Valley, El Dorado County.—The pound of St. John's Day rye was sown on well manured soil, and yielded nine pounds. The grain is larger and whiter than any other rye. The straw is large and strong, and did not lodge in wet weather, as other rye did.

W. A. McKaig, Little Stony, Colusa County.—The St. John's Day rye sown in February, made a good appearance and was quite satisfactory, though it was quite evident that it should have been sown earlier.

Phil. Hope, Coulterville, Mariposa County.—The St. John's Day rye, sown January twentieth on a hard, dry knoll, covered mostly with fine quartz pebbles, made a splendid growth, with enormous heads, but was destroyed by grasshoppers before it matured. I am sure that this St. John's Day rye is the rye that we mountain farmers have been waiting for.

Mrs. J. S. Wright, Willits, Mendocino County.—The St. John's Day rye was sown in February. From some cause the heads did not fill. Most of the heads had nothing in them, and it was not worth cutting.

SWEDISH SAND RYE.

This variety came to us with high recommendation for sandy soils. We have not yet received much information of its growth in this State. The following alludes to it favorably:

T. G. Turner, Lower Lake, Lake County.—The Swedish Sand rye sent me last spring (1886) was sown under very unfavorable conditions, but made a very fine crop. It was sown on a bleak, dry hillside—red soil. The straw grew to a height of seven feet, stood up well until quite ripe, had very large heads, and the grain was very plump.

OATS.

The following notes are in reference to varieties distributed by the University:

S. B. Hatch, Ferndale, Humboldt County.—The Hoptown oats did well considering the season (1885), which was very dry. I got about eighteen pounds of very nice oats from the pound sown. They were sown May first, which was very late, especially as the spring proved so dry.

C. O. Tucker, Ballona, San Diego County.—Black Tartar oats are valueless for this section, not being able to withstand our hot spells.

J. M. Berry, Wheatland, Yuba County.—The Black Tartar oats were splendid; grew to a good height, and bore many grains to the stalk.

O. S. Phelps, M.D., Blocksburg, Humboldt County.—In spite of the dry year of 1885, which has been a severe test, the Scotch oats, sown May eleventh on dry hillside soil, have yielded well and given a fine plump grain—more so than my common oats sown in March upon moist, rich ground.

CHINESE BUCKWHEAT.

This is a hardy variety obtained some years ago from China. It proved hardy and prolific on the University grounds, and seed was distributed in 1884. Reports received indicate that it has no special advantage in the matter of grain product over the common variety. Its long blooming season which is mentioned by different experimenters might be of value to bee keepers, if there should be any occasion to make bee pasturage which would yield so dark a honey. In some situations, sown late, it might be

useful in providing winter stores, as it continues blooming so late in the season. The following are notes from reports received:

John Turley, Glen Ellen, Sonoma County.—I sowed the Chinese buckwheat on dry ground and the yield was satisfactory.

F. Riley, Morro, San Luis Obispo County.—Sowed the buckwheat June tenth and it ripened October first. It did well and compared favorably in growth and grain with common buckwheat; could see that it was superior.

William Brace, Laytonville, Mendocino County.—I do not like the buckwheat (Chinese); the berry is too small.

William Haddox, El Monte, Los Angeles County.—Chinese buckwheat sown June 15, 1884, came up well and grew rapidly. It began to bloom and continued to bloom for nearly four months. At first it made no seed, but afterwards a little seed formed. It grew long straw, which fell down and matted closely. It is not so rank this year (1885), but is still growing (October thirteenth), and blooming and making very little seed. It seems to me that it is not adapted to this climate, but I will try it again.

F. Riley, Morro, San Luis Obispo County.—The Japanese buckwheat did well, though I do not see that it is superior to the American.

W. H. Mullen, Big Bend, Butte County.—The buckwheat did not do well here, as it bloomed too long and did not ripen all at once—too much of a continuation.

APPENDIX III.

REPORT ON ECONOMIC TREES AND PLANTS, AND TESTS OF FRUIT VARIETIES IN THE UNIVERSITY ORCHARD.

By W. G. Klee, Gardener in charge of Agricultural Grounds.

Professor E. W. Hilgard:

Sir: I submit herewith a report on the growth of various economic plants, both upon the University grounds and in other parts of the State, as learned both by correspondence and from my own observation.

I submit also a report on the standard orchard of the University, with tabulated results of my observations and tests of various fruit varieties for a series of years.

Respectfully,

W. G. KLEE.

ECONOMIC TREES AND PLANTS.

THE CAROB (*Ceratonia Siliqua*).

In the reports of this department reference has been made to this most useful tree, and in that of the year 1884 a full discussion of its merits was made, to which we now refer the reader. During the last two years the growth of the young trees on the grounds has been very satisfactory, the oldest specimen in the garden of economic plants having grown at the rate of three feet a year, without a particle of irrigation. The condensed reports given below are, for the most part, very satisfactory; but some of the most interesting points have been obtained during last summer, while I was traveling in the interest of the State Board of Horticulture. I am very much gratified to find at the base of the hills, south of Los Gatos, a number of trees in flourishing condition. The place belongs to Mrs. Elizabeth Arnerich, a widow of a Dalmatian gentleman, who brought the seed with him from Dalmatia a number of years ago, when returning from a visit to his native country. The seed was planted the next season (1873) in boxes, and set out the following year in various places on the ranch, mostly on a red gravelly soil, which, during midsummer, becomes dry to quite a depth. There are in all some twenty-five trees scattered about. Most of them have been moved once, and have, for this reason, been set back for a number of years. The best trees are about twelve feet high, with a stem diameter at the ground of about eight inches. A few of these trees commenced bearing fruit in 1885, and several of them have a number of pods on this year (1886), although from the abundance of the bloom a good many more were expected. The trees, although not irrigated, present a striking appearance compared with other trees, such as figs,

plums, etc., their glossy green indicating their superiority in resisting drought, while the other trees gave unmistakable evidence of the want of moisture in the ground.

We thus have proof that the carob will grow with less water than any other fruit tree (the olive not excepted). This demonstration is just what we have desired, and it warrants us in recommending the tree for general trial in this State.

It will be remembered it is by grafting and budding only that superior varieties are propagated and that the tree is brought into bearing earlier. Mrs. Arnerich had made several attempts to get grafts, but owing to poor packing had failed. She showed a sample of the variety that could be obtained from Dalmatia. The pods were larger than any I have ever seen, fully ten inches long.

The case of the carob tree at James Shinn's nursery (Niles, California), coming into bearing, has been mentioned in the previous report. This year the trees showed a large increase in yield, although a number of pods dropped off just after setting, which was probably caused by a little too much moisture in the ground. Judging from the two instances, the outlook for successful carob growing seems very bright. We give below extracts from letters by persons who received young plants from the University two years ago:

Mrs. W. W. Whitney, San Diego.—The carob trees sent me this spring are doing well; they have received irrigation.

R. Wylie, Napa.—The carobs have made a good growth this season, and, so far, are no worse for the frost.

A. Fouch, College City, Colusa County.—The carob trees grew well last year.

Dr. J. F. Sholl, Los Angeles.—The carob trees grew nicely, from six to ten inches the first year, and are quite ornamental.

P. Miguel, Los Angeles.—The carob trees have done very well.

A. E. Beckwith, Los Gatos, Santa Clara County.—The carobs have started but little, and two died. I have given them frequent waterings.

THE OLIVE.

The olive is attracting a great deal of interest in this State and justly so. California is the only State in the Union that possesses a climate suitable for it. Abundant testimony exists to show that that tree will thrive throughout the larger part of California. The greatest point to be made in favor of the olive is, that it will grow in a soil too dry even for the grapevine and too rocky for any fruit tree. The hills and mountain slopes, not fit for the pasture of even a goat, can be made to produce olives. Precisely such will produce the fruit much earlier than the rich valleys, although in the latter the tree will attain a larger growth. The olive will fill the largest gap in our cultures, and its sphere is such that it will not encroach on any other culture. It is perhaps not as a great and valuable product for export that the greatest importance attaches to the olive in California, but rather as a food product for home consumption. It has often been said that the olive is truly the poor man's tree. In a country like California, where a scanty rainfall is the characteristic of many parts, pasturage, and consequently the production of meat and butter, must necessarily be limited, relatively more so as the population increases. The olive can largely supply this growing deficiency. It is the richest and most nutritious of all fruits, for upon it and bread alone a man may be sustained so as to perform the hardest labor. In the Mediterranean region the olive is of such vast importance that a failure of this crop is a public calamity. A few facts and figures will convey the best idea of its financial value. The crop of Italy, for instance, is estimated to be worth about

200,000,000 francs; Southern France, 61,000,000 francs; in Spain it is variously estimated at from 84,000,000 to 100,000,000 francs, and in the Ottoman Empire at 24,000,000 francs annually.

That both olive oil and pickles of the finest quality can be produced in this State, is a fact not to be questioned, after Mr. Ellwood Cooper, of Santa Barbara, has taken the prize at the Paris World's Fair. Years ago, when the Mission fathers first landed in California, they brought with them two varieties of olives, one of which especially has been propagated throughout the State, in different localities. Although a most excellent and hardy variety, and, as we have lately learned from Mr. F. Pohndorff's investigations, one of the best Spanish varieties, known by the name of Cornezueto, it is here, as in Spain, adapted to the warmer parts of the country only. In a cooler climate the maturing of the fruit falls so late in the season, that it interferes sensibly with the blooming of the next. The importance of introducing earlier ripening varieties is, therefore, apparent. Hence it is a matter of congratulation that private individuals, as well as enterprising nurserymen, have begun to import and propagate French and Spanish kinds. At the experimental grounds of the University, we have received, through Mr. Pohndorff's importations, two valuable varieties, the *Nevadillo blanco*, an oval-shaped olive, of medium size, ripening very early, and the Manzanillo, a rather large olive, of more rounded shape, also of early maturity. No less than thirteen kinds are the generous gift of Mr. J. Rock, of San José; while Mr. L. A. Gould, of Auburn, a gentleman who has been very active in proving the adaptability of the olive to the foothill regions of the Sierra Nevada, has presented five specimens of the Picholine. The latter is a hardy, rapid growing variety. Although the fruit is small in size its great abundance makes it a good bearer. In its time of ripening it has the advantage, for the cooler portion of the State at least, having, at Auburn, matured six weeks earlier than the Mission. The oil made from it in this State is of very agreeable flavor, although not of as heavy a body as that made from the Mission, but it is not at all unlikely that its quality will recommend itself better to people not being used to olive oil.

In addition to these, six varieties have been propagated from seed. While the latter are not sure to develop anything valuable, the differences in foliage and habit of growth indicate widely different types. All the kinds have been planted along a road in a soil and exposure well suited to their development, and we hope before many years to ascertain something definite as regards their value.

Varieties.

As might be expected, a tree cultivated for such a long period of time has developed numerous varieties. Owing to their great similarity, many writers upon the subject, among them Gasparin, avoid the study of these varieties, and give this advice: Cultivate the best variety for your locality, *i. e.*, the one that gives the best oil in the greatest quantity. It seems, therefore, that the best we can do in California is to try a large number of varieties, as it is safe to say that in our diversified climate no one variety will everywhere succeed equally well.

Soil.

From the experience of the older countries, as well as that of California, it seems that the olive will grow in a great variety of soils; the

most important point to be observed being that they shall be warm and well drained. The most striking instance of this kind that I can recall is from my own experience. Some years ago I brought a few rooted olives to a place in the Santa Cruz Mountains. They were set out in the best of soil, in rich and comparatively moist ground. The growth here for two years was almost nothing, although the trees were well attended to. In March of last year they were removed to different places, some being planted on a high knoll, where the soil is very sandy but contains considerable lime; others in small pockets on a southeast slope, the soil in this case being very rich in humus. With the former, small rooted cuttings but a few inches high were planted. In many instances the holes in which they were planted were made in the rock, and the roots spread on almost bare rock. Without any further attention than being hoed to prevent weeds from smothering them, all grew right along, the older ones making several feet of growth where they had before made but a few inches. Of the feasibility of setting out such small plants, I shall speak later, but desire here to draw the attention to the fact that the locality in question is a comparatively cool one. This experience illustrates the fact that in different sections the exposure should be different. In a warmer section, such as Winters or Vaca Valley, evidently the southern exposure on a sunny slope is not needed to produce abundant growth. We find thus on Mr. John R. Wolfskill's place, on Putah Creek, perhaps the largest trees for their age in the State. Some of these growing on level ground, and twenty-one years old from the cutting, when measured by me several years ago, were over six feet in girth.

Propagation.

The mode almost exclusively used in California is from cuttings, which are set either in the permanent site or in nursery rows. We quote Mr. Cooper, in his treatise on "Olive Culture:" "The common and preferred method is to plant the cuttings, taken from trees of sound wood, from three quarters of an inch to an inch and a half in diameter, and from fourteen to sixteen inches long. These cuttings should be taken from the tree during the months of December and January, neatly trimmed without bruising, and carefully trenched in loose sandy soil. A shady place is preferred. They should be planted in permanent sites from February twentieth to March twentieth, depending upon the season. The ground should be well prepared, and sufficiently dry so that there is no mud, and the weather should be warm. In Santa Barbara, near the coast, no irrigation is necessary; but very frequent stirring of the top soil with a hoe or iron rake for a considerable distance around the cuttings is necessary during the spring and summer. About three fourths of all that are well planted will grow. My plan is to set them twenty feet apart each way, and place them in the ground butt end down, and at an angle of about forty-five degrees, the top to the north, barely covered. Mark the place with a stake. By planting them obliquely the bottom end will be from ten inches to one foot below the surface."

This mode of propagation, especially in a changeable climate, is liable to several objections. One is that the large cuttings often remain dormant for several years, thus causing an uneven stand. By first rooting the cuttings in nursery rows this, of course, is avoided, but never will so fine a root system—almost equal to that from seedling plants—be developed as by starting the trees from small *herbaceous* cuttings. For at least the cooler parts of the State we do not hesitate in recommending this method:

Take from young, growing trees the young tops, when neither very soft nor perfectly hard, having three to four sets of leaves, and cut with a sharp knife below a joint. Put in a little frame with sand. In the course of three to four months the little cuttings will have rooted, and should then be potted in small pots, where they should remain until well rooted. In a few months more they will be found ready to set out. When very warm weather prevails a thin mulching around the little tree may be advisable, but when a moderate temperature prevails a few waterings in a month will be all that is necessary—and even this only in an unfavorable spring. It should be added that nothing is gained by setting out the tree before the soil is warm, as it will not grow. The trees referred to previously as planted in the Santa Cruz Mountains were propagated in this manner, and have received no irrigation since setting out. Trees raised from such small cuttings resemble closely young seedlings, and form a beautiful root system.

The young trees raised in this manner, and set out at the experimental grounds at the University in May, 1885, have made a remarkable growth. When set out at that time they did not average more than eight to ten inches in height—mere thin little switches. They were well cared for, and the ground never allowed to dry out, being watered four times during the dry season. When reaching the height of three feet they were pinched so as to cause them to branch; of the branches thus made three or four were left to form a head. This season they received two irrigations, although they probably would have got along without it, and are now, by the end of the season, fine young trees, with a well developed head four to five feet in diameter, and have equaled if not exceeded grafted trees a year older; especially is this the case with the Nevadillo blanco.

To get cuttings from large truncheons, such as are imported from Spain and other countries, proceed in the following manner: Cut the truncheons in pieces about eighteen inches long, split those pieces in two, put the halves so made into the ground horizontally, with the bark side up, covering with soil four to five inches deep. Let such bed be in a warm, well-drained place, kept moderately moist. In a few months a large number of young shoots will break through the ground. When of suitable size and hardness, as before described, take the cuttings and treat in the manner previously mentioned.

Growing Olives from Seed.

This is a mode little practiced so far in this State, but worthy of adoption. Of course the process necessitates grafting or budding. It is the general practice in France to do this after the tree has formed its main branches, either budding or grafting into these during the month of May or June.

The advantages of seedling stocks over cuttings are many: First, vigor of the tree, which produces for a longer time, and more regularly; second, its great hardiness and ability to accommodate itself to the most arid and rocky soil; third, great abundance of horizontal as well as deep-growing roots, especially deep ones, the latter enabling the tree the better to resist wind and frost; fourth, a better form in general and easier to develop and guide than that obtained from a cutting.

The olives should not be planted with the pulp, but must be cleaned of this either by letting them rot in a pile or by putting them into an alkaline solution. A simple way to hasten germination is to break the pits, taking care not to hurt the germ. An instrument similar to the nutcracker has

been invented in France which is said to work very well. When the kernels are deprived of their shell they are steeped in a compost or mixture of cow-dung and sandy soil, and are sown thickly in the month of April. If it is thought to be too much work to take the kernel out of the pit, they must be soaked in an alkaline solution.

The seedling olives grown at the experimental grounds were treated with an alkaline solution of one fourth pound of concentrated lye to the gallon of water. Most of them sprouted the first year, although there were a few stragglers produced the next year. Planting the naked kernels gives the quickest result. Without using this artificial means the seeds will remain dormant at least for two years.

The failure in growing plants from the olives produced in this State is clearly due to the fact that the common Mission olive has, at least in most parts of the State, but a small percentage of well-developed germs. This has been observed by Mr. J. R. Wolfskill, of Winters, who told me that he had broken hundreds of pits without finding a sound germ. Our experience at Berkeley has been similar, although the last year's crop showed a larger percentage than was the case in previous years. Mr. E. Cooper in his treatise speaks of the failure to get any Mission olives to grow from seed, and I find upon inquiry that he has also observed the non-development of the germ. It is my belief that other varieties, and perhaps even the common Mission, in other localities will be much more fertile. The following facts seem to substantiate this:

To obtain more insight in the matter, Mr. C. H. Dwinelle obtained for me from Mr. A. S. White, of Riverside, some dried olives, which upon examination proved to have nearly fifty per cent of apparently good kernels. The result of sowing was, however, very small, some five to six per cent only germinating, nevertheless enough to prove that there is a difference in the fertility of the seeds of the Mission olive in different parts of the State; although, perhaps, the cause may lie in difference of variety. There exists in Southern California at least one other variety besides the common Mission—a variety of more straggling habit and with larger fruit. It is generally mixed with the ordinary kind, and not often recognized as being distinct.

The percentage raised from the European seeds of six different kinds was about fifteen to twenty per cent. To save considerable work in selecting olives for seed, they should be put in pure water; all those that sink at once will be found to have the seed wholly or partly developed. In Europe the wild olive is much used for grafting stock. This species is nearly always fertile, and it would pay any one who desires to grow olives on a large scale to get a quantity of its seeds.

Much experience in grafting the olive in this State has not been had as yet, although it is done regularly in the older country. The only grafting that has come under my observation has been done under glass and on young stock, and only when very carefully done has been successful. Budding has been practiced to some extent, but has not been as successful as expected. Our own experience has been but limited, and not the most encouraging. The buds apparently take, but in the spring the growth of the wood seems to push them out.

Time of Bearing.

It is argued by many people that the olive requires an excessively long time to come into bearing. In favorable localities this is by no means the

case. In the southern part of the State large olive cuttings commence to bear in the fourth year. Mr. Cooper, of Santa Barbara, reports two gallons of berries on some of his best trees at that age, and as much as thirty gallons from the best at six years. Mr. Kimball, of National City, San Diego County, reports similar results. Our own experience at Berkeley, where the summer temperature is very low, must be termed very encouraging. Two small trees, but a few feet high, brought from the Mission of San José, were planted in 1873, by Mrs. Jeanne Carr. For two years after Mrs. Carr's departure they were neglected, but answered very quickly to kind treatment; and after six years from planting produced some fruit, and have produced full crops every two years, steadily increasing. The yield at eight years thus was about fifty pounds; at ten years, over one hundred pounds per tree, while this year each tree averaged two hundred and twenty-five pounds. In the off years the yield has been about one quarter as much. Compared with warmer localities, where the Mission olive ripens earlier, the yield perhaps looks small, but with varieties better adapted to our cooler climate the result would doubtless be different. As olives are worth four cents a pound the profit would be very good. Judging from what we know about the adaptability of the olive, it would seem that an olive grove would be one of the safest investments all over the State, provided no overproduction should take place.

The two trees referred to at the University grounds were last year pruned out considerably, and a great deal of bearing wood removed. They are now again full of fruit, which bids fair to ripen a good deal earlier than it did two years ago.

Enemies of the Olive.

There are, however, a number of drawbacks, chief of which are the insect pests. So far, with the exception of some twig-borers, the only insect enemy the olive grower has had to contend with is the scale, coupled, however, invariably with the black fungus, which it is now pretty well understood feeds upon the viscid excretions of the scale. So severe has the attack of this scale been in the moister parts of the State, that only the most persevering men, led by Mr. Cooper, of Santa Barbara, have succeeded in its suppression.

I do not believe as some do, that the sole remedy for this evil is to leave the coast and seek localities where, owing to the intensely dry air, the olive scale seems to be an impossibility. Other factors governing the condition of the tree, and not often considered now, will show themselves. It must be remembered that with the influence of the sea we also lose the more uniform climate, which always has been considered of prime importance to the olive. But by starting with thoroughly clean trees and keeping them so, I think there need be no fear. For the purpose of keeping the trees clean from the first, whale-oil soap dissolved in a decoction of tobacco water, viz., one pound of soap and one half pound of tobacco per gallon, is to be recommended. It is here that the small green cuttings previously described are much to be preferred to old cuttings, which nearly always are more or less infested with scales. But the scale is by no means the only formidable enemy the olive grower of the Old World has to contend with.

The principal ones to be feared there are the *Dacus oleæ*, a dipterous insect affecting the pulp of the fruit; the olive moth, *Jinea oleæ*, which, like the apple moth, feeds on the seed of the olive; finally, the *Psylla*, a hemipterous insect. Of these three the first, *Dacus oleæ*, is by far the most destructive. According to Pouchet it destroys in France yearly 3,000,000

francs' worth of olives; and the other coasts of the Mediterranean do not escape its ravages. It seems to breed all the year round. The fly lays its eggs, one to several, in the pulp of the olive, and the larvæ when hatched live on the pulp next to the pit. It remains here as chrysalis, and finally leaves the olive a flying insect. Whether it has left the fruit before the harvest, or is crushed with the oil, it is almost equally objectionable. This insect is *la mouche* of the French and *macha del olivo* of the Italians.

The olive moth works almost like the apple or codlin moth. The eggs are laid while the pit is still young and tender, the larvæ living on the kernel of the olive until it leaves it a complete moth, causing the fruit to drop prematurely. This insect does not, however, confine itself to the fruit alone, but works also on the leaves and bark, causing tuberosities and crippling of the leaves.

The *Psylla olex* is a hemipterous insect, which, like the dreaded white cottony scale, covers itself with a white, viscid covering, fastening itself on young foliage and fruit.

We have called the attention to the existence of these pests just now when large shipments of olive truncheons are imported. It is the duty of every one who receives them to guard against such pests by proper disinfection. For this purpose, I think the vapor of bisulphide of carbon the best. A large drygoods box clothed with tin is easiest to get; for a box five to six feet long and four feet high, a couple of ounces of bisulphide will be sufficient for a charge. Place a few boards loosely over the cuttings and spread some rags over these, and pour the liquid on these, close box tightly, and let the cuttings remain in the box for two hours.

PEAR-SHAPED GUAVA (*Psidium pomiferum, or P. pyriferum*).

Reference to this fruit has been given in previous reports. The climate of Berkeley has proved too severe for it, but I have seen it in the gardens of Santa Paula, Ventura County, and also at San Diego Bay, where it has proved comparatively well adapted to the climate. The extracts from correspondents given below confirm the opinion that it will succeed in sheltered localities in Southern California. Mr. Tucker's experience, that it is hardier than the strawberry guava, is unique and at variance with what we have seen elsewhere. We quote from correspondents as follows:

Byron O. Clark, Pasadena, Los Angeles County.—The pear-shaped guava bears well and is a desirable fruit.

C. O. Tucker, Ballena, San Diego County.—The pear-shaped guava was so long on the road (thirty-two days) that it was nearly dead when received. By good care I have revived it, and, to my surprise, it is hardier than the strawberry guava. It is growing in a rather heavy black soil. On October 9 (1885) it stood quite a heavy white frost that nipped young orange twigs.

A. E. Beckwith, Los Gatos, Santa Clara County.—I have one yellow guava, received in 1884. It is but eight inches high, but now is growing nicely.

D. J. Parmele, Vacaville, Solano County.—The two pear-shaped guavas I received in 1884 I put in four-inch pots to get them gradually used to the sun, but they failed after growing about two months.

F. H. McCullagh, Los Gatos, Santa Clara County.—The pear-shaped guava received two years ago seems to be perfectly hardy and is doing well.

Chas. A. Storey, St. Helena, Napa County.—The guava I received did not seem to thrive well and eventually died.

C. F. Leiding, Sonoma.—The guava did very well until the cold came, and then it was killed by the frost.

Wm. Heaven, Boyle Heights, Los Angeles County.—The pear-shaped guava is thriving, and I consider it adapted to this climate.

A. Keith, Riverside, San Bernardino County.—The guavas are growing nicely, but they seem to be very tender, much more than the orange and lemon.

STRAWBERRY GUAVA (*Psidium Cattleyanum*).

This delicious little fruit has proved hardy in the climate of Berkeley, and although late has produced ripe fruit for the last two seasons. The most luxuriant bushes we have seen were at the High Bros. gardens near National City, but it flourishes in many localities along the southern coast, as at San Diego, San Gabriel, Ventura, etc. Its time of ripening, from October to December, fills a gap when comparatively few fruits are to be had fresh. Judging from our experience here we are satisfied it will grow in most localities where young orange trees have succeeded.

MELON TREE (*Carica Papaya*).

Mention of this tree has been made several times in previous reports, but we have never been able to report that a favorable location had been found for it. Last year we received a communication in regard to it from Mrs. W. W. Whitney of San Diego, to whom a single specimen had been sent the year before, and this season, while traveling in the interest of the State Horticultural Commission, I had opportunity to examine it. The Whitney residence stands on an elevation on the sloping hills above the Sweetwater River, some four miles from National City, San Diego, overlooking the bay. Close to the house, and partly sheltered from the west winds, stands the specimen of the carica, which, when sent from here in the spring of 1884, was only about three feet high. It is now a fine tree over twelve feet high and twenty-four inches in circumference at the base. It is almost constantly full of flowers, and sets fruit all along, some of these having reached five to six inches in size. I was rather surprised to see the fruit of such a size, as I thought the carica to be dicœcious, but it seems after all that at least some trees contain both kinds of flowers. The carica seemed perfectly at home in this location, its luxuriance showing itself in every respect, the leaves reaching a size of more than twenty-four inches in diameter. The experiment is very promising, and I hope to see it repeated. The tree, aside from its curious economical properties (see the report of 1882 of this department), is highly ornamental. In appearance it is a combination of the aspects of a palm and a fig tree, having the single straight trunk of the first, with the peculiar swelling at the base and leaf of the latter. This is so striking that it has received the name *carica*, this being the specific name of the fig.

Hovenia dulcis.—Is a Japanese deciduous tree, belonging to the *Rhamnaceæ* (Buckthorns). It bears a fruit considerably esteemed in Japan. Wherever it has been tried, both here and in Southern California, it has proved a handsome, rapidly growing tree. The few trees here are from four to five years old, have straight, smooth trunks six feet high, and well developed crowns. The leaf is the shape of that of the linden. So far there has been no sign of blooming. Even if the fruit should prove of little value, the tree will stand well for shade and ornament.

Niphelium Li-chi.—The Chinese-nut tree, so familiar to the Chinese. We have received, last year, some of these from the Golden Gate Park, and they are now being tried in different places in the garden.

PISTACHIO.

The *Pistacia vera*, or pistacio nut tree, is a small tree of spreading habit of growth. The nut is known, also, as green almond, owing to the kernel having this, for a seed, exceptional color. They are eaten raw or roasted, while large quantities are used in candies. Our own experience, as well as the experience of others, shows this tree to be a very slow grower in this State, although thriving better in the hotter part of the State. The largest plants we have met with are at the nursery of James Shinn, Niles, Alameda County, and are more of a nature of a bush than a tree. Although several years old, they are but six to eight feet high.

The pistachio should be set out permanently when small, as it is difficult to transplant when older, owing to the very long taproot.

To encourage growth of this tree, it may be grafted on the Pistacia terebinthus, a tree we shall refer to later.

The following are condensed reports received from those who received plants from this department:

D. J. Parmele, Vacaville, Sonoma County.—The pistachio nuts, received two years ago, were planted among the orchard trees. They are now growing, but are not over one foot high. They stand the winter weather well, and remain green.

A. C. Weeks, San Gabriel, Los Angeles County.—The pistachio nut trees are alive, but grow very slowly.

George Rothermal, San José.—The pistachios have done very well, every one having made a growth of one to four inches. We have already (November 21, 1886) had heavy frosts in this locality, but it has not affected them.

Mrs. Harris, Fowler, Fresno County.—One of the pistachio nut trees survived, and, although cut down by grasshoppers, made a second growth of twenty-two inches.

A. B. Butler, Butte City.—The little pistachio nuts are just alive. I find them very slow growers.

M. J. McBride, Dixon, Solano County.—The pistachio nuts started, but died when the warm weather came.

Will. Haddon, El Monte, Los Angeles County.—The pistachio nuts suffered so much from the alkali in the soil that I had to remove them.

F. G. Storey, San Gabriel, Los Angeles County.—The pistachio nuts do not thrive; they are only ten inches high.

A. Gall, Stockton, San Joaquin County.—Of the pistachio trees received one died; the others seemed healthy enough, but are very slow growers. I set them out in a wet, shady place, but finding they did not succeed, I removed them to a more exposed place, where I find they are doing better.

C. H. Mero, Pomona, Los Angeles County.—The pistachio nut tree received two years ago has been growing very slowly, and is but a foot high.

PISTACIA TEREBINTHUS.

Is a small tree of much quicker growth than the *P. vera*. It is a native of the Mediterranean region, yielding the fragrant chio or cyprian turpentine, which exudes from the tree. The tree has proved quite hardy in Berkeley, where, in the garden of economic plants, a large bush matured fruit. Owing to want of proper fertilization, the fruit dropped off early and no germ was found. The tree seems far better adapted to our climate than the *P. vera*. This summer we saw this tree at the Rixford Ranch, Sonoma, where it was growing finely and had attained the size of trees twelve to fifteen feet high. Although without a particle of irrigation, they looked even less in want of water than the native oaks. The soil is a heavy adobe. Judging from their behavior, they could not be more at home than they are here.

The pistacios are dicœcious, pistillate and staminate blossoms growing on different trees, hence the necessity of having more than one tree.

CAMPHOR TREE (*Camphora officinarum*).

The usefulness and merits of this beautiful tree has been discussed in previous reports. We are happy to state that the more we learn of the tree with the more favor we look upon it. Large trees have been brought to my notice this summer, notably a fine specimen in the grounds of Alvinza Hayward, Esq., at San Mateo. This tree is about forty-five feet high, and is branched low to the ground, and is fully three feet through at the base. Its age, as nearly as I can learn, is only about twenty years. A tree of similar size is on Major Rathburn's grounds, near Mayfield, Santa Clara County. There is no doubt that the tree will be found adapted to a large portion of the State, and will grow without irrigation wherever a pear tree will succeed without it. From actual trial here, in Mr. Wickson's garden, in Berkeley, it has been proved that the tree stands pollarding as well as a willow, a characteristic of considerable importance, if its cultivation for gum camphor should be undertaken. As the extracts below show, nearly wherever sent, the camphor tree has given great satisfaction:

C. H. Mero, Pomona, Los Angeles County.—The camphor tree sent two years ago is three and one half feet, and is a beauty.

A. E. Beckwith, Los Gatos, Santa Clara County.—The camphor tree grew but very little the first year, but it has grown well during this season. It is now two feet high.

D. J. Parmele, Vacaville, Solano County.—The camphor tree I received from the University was killed by the sun finally, although shaded at first for a considerable time.

F. H. McCullagh, Los Gatos, Santa Clara County.—The two camphor trees are doing very well, indeed, and seem to be perfectly hardy. My place is a good deal higher than the town of Los Gatos.

William Heaven, Boyle Heights, Los Angeles.—The camphor trees are thriving here. I consider them well adapted to our climate.

Harvey Wilcox, Los Gatos.—The little camphor tree sent here in 1884 grew nicely. It is about three feet high.

Dr. J. Scholl, Los Angeles.—The camphor tree received eighteen months ago is three and one half feet high.

Byron O. Clark, Pasadena, Los Angeles County.—The camphor is growing and seems to do well.

Mrs. A. E. Watson, East Oakland, Alameda County.—The camphor tree received in 1884 was very small and tender the first year. It is now a fine, healthy plant, three feet high, and very handsome. It was not injured in the least by the frost of last year.

W. Still, Sonoma.—The camphor tree is a healthy and a very vigorous grower.

F. G. Storey, San Gabriel, Los Angeles County.—The camphor tree bids fair to be especially handsome. It has attained a height from three to four feet.

J. Parker, Castroville.—The camphor trees were flourishing finely, but some stock got inside the inclosure and destroyed them.

Geo. Harvey, Forestville, Sonoma County.—The camphor trees sent me in the spring of 1884 have grown nicely. My soil is redwood soil on the Russian River bottom.

A. Gall, Stockton.—The camphor trees are both doing well; one is about sixteen inches high.

CINNAMON.

Cinnamomum glaucum.—This is a species of cinnamon, from which an inferior kind of cinnamon, classed with the cassio bark, is produced. The tree is apparently as hardy as the camphor tree, and almost as rapid a grower. Outside the experimental grounds, we have not met with this species, except at the grounds of Mr. O. W. Childs, Los Angeles, where a beautiful specimen, fully twelve feet high, can be seen. It resembles the camphor tree closely in habit and growth.

Cinnamomum sericeum.—This is another Japanese species. We have not had sufficient time to try it in the open air here. It will grow in the coast region of Southern California.

CATALPA SPECIOSA.

The catalpa, which has found so much favor in the Western States, will never be regarded with the same favor here, although there are localities where it will be found a valuable shade tree. Wherever the various species of eucalyptus will flourish, they will always be found, being better adapted to the winds which generally prevail along the coast, while the soft leaves of the catalpa are very liable to be torn to pieces. In inland sections, where the seasons are more distinct, and the winds, during spring, less persistent, the tree will find a suitable place.

The following items are from letters of those who have grown the tree:

S. G. Baker, Norwalk, Los Angeles County.—The two small catalpas sent me in the spring, a year ago, are now eight feet high. They are in moist soil. I only keep the weeds away from them, but do not cultivate them otherwise.

Dr. J. Scholl, Los Angeles.—The catalpas grew about four feet each season. The E. globulus grows twice as fast.

William Hadden, El Monte, Los Angeles County.—The catalpas sent two years ago are seven feet high.

F. G. Storey, San Gabriel, Los Angeles County.—The catalpas speciosa are from sixteen to eighteen feet high.

L. J. Harbison, Vacaville, Solano County.—The catalpas are rapid growers and doubtless valuable.

A. B. Harrison, Walnut Creek, Contra Costa County.—The catalpas are growing well. One is over six feet high, and promises to be a beautiful tree.

BLACK WATTLE (*Acacia decurrens*).

In the report of 1882, attention was called to this tree as a profitable source of tanbark. Since the writing of that article we have become fully convinced of the complete adaptation of the tree to the coast region of the State, from San Francisco southward, and even to many interior points in the State. In portions where fuel is high its wood would always be valuable, and this, as well as its near relation, the "Silver wattle" (*Acacia dealbata*), would be desirable trees to plant for the wood supply. In this connection, we cannot omit the "Black wood acacia" (*A. melanoxylon*), which is equally as fast a grower and furnishes a most valuable timber which, in Australia, is used largely for axe handles and tool handles in general; in fact seems to be there a substitute for ash.

There is a point connected with the growing of acacias which we must not pass by. It is the great danger of the cottony scale (*Icerya Purchasi*) Maskell, infesting these trees, for which they seem to have a great preference. In fact, any tree grown within a few miles of infested trees will be sure, sooner or later, to become covered with the miserable pests, which if not soon eradicated from the localities they are found in now, will eventually spread all over the State. We refer the reader to our report of this insect in the report to the State Horticultural Commissioners (1886).

Below is given extracts from reports on the growth of the wattle:

Mrs. Harris, Fowler, Fresno County.—The black wattles grew to quite a size but did not stand transplanting.

Frank Moore, Anaheim, Los Angeles County.—The seed of the black wattle I received this spring was planted in April in two different soils—one sandy, the other black and somewhat adobe. Plants on the former soil now stand three feet high; on the latter they did not do well, only making a growth of a few inches. My cultivation was simply to keep the surface loose and free from weeds.

F. W. Marwin, San Francisco.—I planted the wattles in a place much exposed to the winds. The soil is mostly sand. The seeds were soaked twenty-four hours before planting. The plants have been coming up ever since, and seem quite hardy; the tallest are about fourteen inches high.

B. O. Clark, Pasadena, Los Angeles County.—The black wattle flourishes finely here.

A. B. Butler, Butte City, Colusa County.—I find the black wattle well adapted to this climate. The trees are rapid growers, and I think will be valuable for timber.

F. A. Korn, Anaheim, Los Angeles County.—The black wattle seeds were planted in a furrow, and came up pretty well, but before I was aware of it some were killed by the hot sun. After being shaded they grew well, but it became too dry, and watering with well water killed many of them. Before I could get ditch water to them they all died. This season was too unfavorable for growing trees. I shall try them again.

L. Griffin, Batavia, Solano County.—The acacia seed sprouted well, and the trees grew about one and one half feet high. They would, no doubt, have done better by proper cultivation.

J. Parker, Castroville, Monterey County.—The black wattle is doing fairly well. A neighbor has some growing in a lighter soil. They are doing much better.

William Still, Sonoma.—The black wattle trees are seven feet high, and grew five feet this season. I have a number of different plants growing, as, for instance, the English laurel. It grows well in the spring, and then stops; but the acacia never stops. I think the tree well suited for Sonoma.

EUCALYPTUS MARGINATA.

In the report of 1880 of this department, can be found an account of this valuable tree, which is a native of West Australia and is there known under the native name of Jarrah or Yarrah. Its chief value lies in its extremely hard wood, which is not attacked by any known borer, and the timber is sought for far and wide. Unfortunately, the trees planted on the University were in a cold location, and the following season after the report was published were killed to the ground by a sudden and severe frost. This would have ended our record with them in this locality, if a few of them had not been given to various people in the vicinity. Among them one was planted in a private garden on Claremont Avenue, in a sheltered position. Two years after, my attention was called to it, and I found a beautiful straight growing tree with dark green foliage veined with bright red, very unlike the more common species of *Eucalyptus*. This tree, in the third year, stood ten feet high with a diameter of three to four inches at the base. In the fourth year, it is fruiting, but, owing to the close proximity of several acacias, is not growing very fast. Enough, however, can be seen from the behavior of this tree, that in a slightly milder climate than prevails in most parts of Berkeley, it would be a perfect success. Even here, many locations could be selected, where it would prove hardy, but it is especially for the southern, treeless portion of this coast, where timber of all kinds is much more valuable than farther north, that we especially recommend this valuable tree. Seed can be procured at San Francisco seed houses or direct from Australia.

ITALIAN CHESTNUT (*Castanea vesca*).

Although pretty well known in this State, I desire to call the attention of all planters to the fact that this species, like many others from Southern Europe, is far better adapted to California climate than their near relations east of the Rocky Mountains. I have found this to be true in a remarkable degree of the chestnut, and can recall several instances in different parts of the State where the Italian chestnut grown alongside the American chestnut has shown superiority. From personal trials I can recommend this chestnut for heavy, clayey soil, even if it be quite rocky—such soil as is found in the Coast Range about Berkeley and Oakland. A young tree six years old from the seed, growing on the grounds, having but little irrigation, has reached the height of fifteen feet, and is showing, this year, staminate blossoms.

ORIENTAL SYCAMORE (*Platanus orientalis*).

A beautiful, straight-growing tree of very rapid growth, seemingly well adapted to our climate. For avenues and street planting it is well suited. The timber is valuable, and used for furniture and other cabinet work.

CORK OAK (*Quercus suber*).

From time to time cork oak acorns have been introduced into this State, and a number of specimens of this useful tree may be found in various sections; there being, to the writer's knowledge, large specimens in Sonoma, Sacramento, Santa Clara, Tulare, Santa Barbara, and Los Angeles Counties. The great resemblance of the cork oak, both in habit of growth and foliage, to our California "live oak," points to its adaptability to our climate. This close resemblance to the live oak has been the cause, in several instances, of its destruction, the workmen at their weeding having mistaken the young plants of this oak for the more familiar native live oak. Although of slow growth, the cork oak offers a promising investment to those who can afford to wait some time for returns. In the first place, this tree will grow in soil ill suited to most other trees; as, for example, strong clay, and even ill drained soil. An experiment to prove this has been successfully carried out on the grounds in Berkeley. The tree in question has not alone been planted in miserable soil, but has been twice singed by carelessly caused fires. Another favoring fact is that the cork oak is easier to transplant than any other evergreen oak, particularly so when stripped of part of its leaves. In order to test the tree farther, acorns were bought of Mr. Hutchinson, of San Gabriel, Los Angeles County, who has a tree of considerable size in full bearing. Owing to ravages of birds, which were found destroying the young germs just when they were breaking the ground, the supply of young plants for distribution is rather limited.

THE ENGLISH OAK (*Quercus robur*).

This species is as great in importance as any oak we might acclimatize. Several years ago we spoke of it, and recommended it highly as the fastest growing hardwood timber tree that could be planted. Later experience fully justifies this belief, and it is the intention of the Department again to distribute in large quantities the acorns and plants. It is to be regretted that, owing to the ravages of gophers, only one tree of quite a number set out on the University campus five years ago has survived, and owing to the too close proximity of eucalyptus trees, is not doing well. Fortunately, however, there are several trees originally sent out from the institution scattered about Berkeley. A specimen planted on Professor Hilgard's ground five years ago has reached eighteen feet, and this year showed blossoms, none of which matured acorns. To test the adaptation of the English oak on the Contra Costa hills, several hundred trees were planted this spring on the hills back of the University, and although planted late most of them have survived the dry season without irrigation. The tree requires a deep soil, heavy loam being preferable to a light sandy soil. The extracts from the correspondence of the parties having received small trees and acorns, show the awakening interest for the planting of timber and shade trees; and, as will be seen from these extracts, most of the English oak trees have done well:

A. Boyd Doremus, Santa Barbara.—The one half dozen English oaks received last spring were planted in different localities; two in grayish colored loam have grown to the

height of four feet; two others, being transplanted, made very little growth; one other in low, damp ground with black, rich soil with considerable alkali, died; another was killed by gophers, and two others in different soil are probably suffering from gophers also.

Mrs. C. Pagani, Mayfield, Santa Clara County.—The acorns you sent are now fine little trees.

Harvey Wilcox, Los Gatos, Santa Clara County.—The acorns sent came up nicely, but they do not grow very fast. They are about one foot high; they were planted on moist ground, light, somewhat sandy, and rich.

R. Wylie, Napa, Napa County.—The English oaks have stood the summer well, and seem quite at home.

A. Fouch, College City, Colusa County.—The English oaks grew well.

W. W. Walker, San Francisco.—The oaks received last year were planted on my ranch, in the San Tomas District (Santa Clara Valley). Most of them are doing as well as might be expected this dry season (1885).

F. G. Storey, San Gabriel, Los Angeles County.—The acorns received two years ago nearly all became trees, and are doing well, being about four feet high.

VARIOUS CHILIAN TREES.

We have growing a number of trees obtained from Chili. Information of their characteristics has been kindly furnished by the Chilian Consul. The first plants grown of these were from the San Francisco Bulletin distribution:

Boldoa fragrans.—A small tree, remarkable for its fragrant foliage, which is employed as a remedy against kidney diseases. In Berkeley the boldoa grows as a bush, with drooping branches. The foliage is of a handsome, deep-green color. Like most of the trees of Chilian introduction, it is of rather slow growth, this one having grown, in four years, only three to four feet.

Persea Lingua.—So called "lingue" produces a wood much used for furniture. The bark also contains much tannin. Until well established on the spot it is also of slow growth here, and therefore not to be recommended for any purpose but ornament.

Espino acacia, or Mimosa Cavenii.—This is a bush with tough, hard wood, of red color, in Chili, much used as a hedge plant. It thrives well here in Berkeley, making a fair growth, and deserves notice as a valuable but slow-growing hedge plant, for which purpose its strong thorns render it especially useful.

Bellota Miersii.—An evergreen tree with handsome foliage, resembling a bay tree. Also of slow growth in Berkeley.

Mytenes Chilensio; Maiten.—An evergreen shrub or small tree, having proved of rapid growth in Berkeley, where it seeds freely. It must be regarded as suitable for massing with shrubbery, as in parks. It might also be used as a hedge plant, as it stands the knife well.

Psoralea glandulosa.—This is a large shrub of drooping habit, having also proved of rapid growth and suitable for groups in large places; perhaps, also, in sand, for the purpose of preventing drifting.

TEXTILE PLANTS.

Esparto grass, Stipa tenacissima.—The celebrated esparto grass was introduced two years ago, and has been found perfectly hardy; though at the start rather difficult to handle in a heavy soil. It is evidently more at home in sandy land. It is especially along our shores that the grass

might be advantageously planted. The esparto grass may be propagated from seed, but more readily by division of the clumps. The great importance of this grass to the civilized world is best seen by the extract from the United States Agricultural report:

The esparto grass (*Stipa tenacissima*) Sinn. A member of the family graminæ; grows in Spain, Portugal, Crete, Sicily, Southern Italy, and North Africa. It is the alpha of the Arabs, the esparto of Spain, and is supposed to have been the spartum of the Latins, described by Pliny as one of the most important plants of Spain. It grows in tufts or clumps on sandy shores and gravelly hills, and is harvested from May to July, by peasants, who, protecting their feet and hands by stout coverings, pull it, by means of stout sticks, around which the stalks are twisted to secure a purchase. It is at once tied into bundles, which are piled into heaps for two days, then dried, macerated, and beaten.

It is estimated that fifty thousand persons are employed in Southern Spain in the collection, preparation, and manufacture of this fiber. Large quantities of esparto thread are shipped to France, where it is used as in Spain, in making carpets, ropes, mats, baskets, sacks, nets, and packing fabrics. It is used as a substitute for hemp in rope making, and in place of horse hair for stuffing mattresses. As cordage it is regarded with as much favor now as in the time of the Carthagenians, from its property of resisting moisture. It is used in Scotch carpet factories in making kidderminster, and in making Brussels carpets, and is also very extensively employed in the manufacture of paper in Great Britain, whither, in 1866, sixty-nine thousand eight hundred and thirty-three tons, valued at $1,508,000, were imported. France and Belgium employ it to make paper and papier maché.

A kind of sandal made of esparto is extensively used in Spain by the peasants, and quantities are yearly exported to the Indies. The Spanish shepherds make hurdles out of it; and the Arabs weave from it household utensils, so impervious that liquid food can be carried in them. Since 1864 small quantities have been imported to the United States. (See a valuable essay by J. R. Dodge, in a report of the United States Department of Agriculture, 1868, p. 260.)

Lygeum sparteum.—Also called esparto grass, and similar in nature to the *Stipa*, but of much less value. It blooms here the second year from seed.

Festuca altissima.—This is another tall grass, extensively used in North Africa for baskets and hat making. Unlike the true forage grasses, the edges of the blades are sharp and saw-like. When dried in the shade the blades are extremely strong.

THE NEW ZEALAND FLAX (*Phormium tenax*).

The appended extracts show conclusively that this useful plant will only succeed in the coast region of the State. For these sections it will always prove exceedingly useful, and as there is a large supply at hand of it at the University, any one not having the plant may have his want filled the coming season. The uses of the New Zealand flax were quite fully outlined in our report for 1882. The following extracts from correspondence show the regions in which it grows well, and the uses made of it:

E. Leedham, Arroyo Grande, San Luis Obispo County.—The New Zealand flax you sent me is doing well.

J. Rastede, Orange, Los Angeles County.—The plants, although having suffered by delay on account of the washout, are all growing and doing well.

W. H. Hilton, Glen Ellen, Sonoma County.—The plant has grown well, but requires irrigation. It was planted in good loamy soil.

James Hodge, Rohnerville, Humboldt County.—The New Zealand flax is growing finely. The leaves are very strong, and good for tying small parcels.

W. B. Fielding, Los Gatos, Santa Clara County.—The New Zealand flax received in 1884 was planted at the lower end of a pond. It grew three to five feet, entirely in shade of alder trees, the first season. In 1885 it started well, but was eaten off by cattle breaking through the fence. The soil is a heavy black adobe mixed with sandstone, strongly impregnated with iron and slightly with petroleum.

E. A. Bosworth, Cayton, Shasta County.—The New Zealand flax grew well during summer, but was killed by the frost in winter. Our altitude is three hundred feet; mercury falls sometimes as low as 12° below zero. I think the plant would be useful for sack-string making, chair bottoms, baskets, etc.

A. Plumley, Byron, Contra Costa County.—It is too dry here for the New Zealand flax.

M. L. Conklin, Newell, Colusa County.—My experience this year has been bitter. The grasshoppers destroyed all our young trees, and some of the old trees and vines, but the New Zealand flax was too tough for them. It has done splendidly, and is very valuable for tying vines and trees.

W. W. Walker, San Francisco.—The New Zealand flax was planted on my ranch in Santa Clara Valley, between Los Gatos and Saratoga. The holes were dug two feet deep and the plants set out two feet apart. They have not done well, and seem to feel the want of water. Our soil is a black, gravelly loam four feet deep. Subsoil, red, gravelly loam.

A. B. Butler, Butte City, Colusa County.—The New Zealand flax does not seem to flourish here; my plants are alive, but I think this section too dry for it.

J. W. Ferris, Stockton, San Joaquin County.—The New Zealand flax is doing splendidly here.

M. H. Anderson, Santa Paula, Ventura County.—The New Zealand flax has grown very well; it has leaves from four to five feet long. I think it will make a useful plant, and do well in this part of the State.

L. U. McCann, Santa Cruz.—Of the New Zealand flax I must speak with unqualified approval. I consider it of great value for textile fabrics, and wonder that manufacturers have not made some practical use of this plant. It grows leaves twelve feet long by six inches broad. I use the strips of leaves constantly instead of twine, especially in my small fruit plantation. The flax leaves look also much neater than unsightly ropes and strings. There is only one objection that can be urged against the fiber: it becomes brittle when it at last is thoroughly dry, but this does not take place before the season is over, and the tyings have to be renewed anyhow.

David M. Balch, Lugonia, San Bernardino County.—The New Zealand flax refused to grow and finally perished. Think the atmosphere too dry and the sun too hot for its well being.

D. G. Perry, Selma, Fresno County.—The New Zealand flax makes but a feeble growth here.

Rolla Butcher, Santa Clara.—The New Zealand flax has done very nicely. I find it very valuable in the garden for tying up plants.

F. G. Storey, San Gabriel, Los Angeles County.—The New Zealand flax requires a great deal of water; only those partly shaded from the sun are healthy; the others are turning yellow.

L. J. Harbison, Vacaville, Solano County.—The flax is of slow growth, and not worth the cultivation bestowed upon it.

F. Barbour, Clayton, Contra Costa County.—The New Zealand flax grows well; it has not blossomed yet.

W. Still, Sonoma.—The New Zealand flax has grown well on the hillside where I planted mine. Some which I gave to a friend in the valley and which was planted on a very heavy adobe soil, did not flourish.

C. Brower, Bakersfield, Kern County.—The New Zealand flax plants received two years ago, were planted on various soils: high ground, sandy loam, bottom land, strongly alkaline, and moist alluvial garden land. All except the one last named died. Until this year it made no growth at all, but has made some progress and is sending up healthy sprouts. In summer the tips of the older leaves died. My neighbors report similar experience, with one exception; this on sandy loam well manured and irrigated weekly during the summer. It is said to be green and healthy throughout, although not of remarkable growth.

Ramie—Boehmeria candida or *nivea*.—The probable importance of this fiber plant need not be enlarged upon. It only need be said that it seems almost settled beyond question that with the aid of one or the other of machines now under trial the wonderful capabilities of this product will not long remain unused. Wherever the plant has been tried it seems to have done well, but its wonderful growth in Kern County seems to indicate that the southern San Joaquin Valley will prove one of the best sections for its successful growth. The following notes are from correspondence:

J. S. Drury, Bakersfield, Kern County.—The ramie plants I received have all grown finely. Some stalks are twelve feet high. This soil and climate, with plenty of water, will grow the ramie to perfection. I sent some stalks to the "Gibson Decorticator," Pittsburgh, Pennsylvania. They pronounce them fine specimens.

William Haddox, El Monte, Los Angeles County.—The ramie I think perfectly well adapted to this climate, and it has grown finely (in spite of the alkali in the soil) to a height of seven feet.

F. G. Storey, San Gabriel, Los Angeles County.—The ramie grows luxuriantly with moderate irrigation. Without removing the ripened stalks it has made two crops in the season, growing seven to eight feet high.

COMMON FLAX (*Linum usitatissimum*).

In California this plant has, as far as we are aware, been cultivated for the seed only, no inducement being offered until lately to raise it for fiber. The variety grown generally in the State for seed is of very low stature, only about one third the height of varieties cultivated for fiber. It is identical with what in France is called "winter flax," and seems to be a very hardy variety. The flower is large and blue. About six years ago, two varieties of flax were introduced by the College of Agriculture, the one called the "Russian," from Pskoff, a blue, flowering variety; the other, the "Royal," a white flowering variety. Both thrive well, and on new soil, especially, made good length, being three times as tall as the common variety. When sown in February they would always do well and develop without irrigation. At various fairs samples of these have been shown and pronounced to be of good quality. Two years ago several more varieties were imported from France, including the "Yellow Seeded," "White Flowering," and "Winter." They have proved well adapted to the climate, but as no inducement to grow flax fiber presented itself, the stock was merely kept up. This season I learned that the California Cotton Mills desired large quantities of flax fiber, and as the Superintendent kindly informed me that the firm would do all in its power to encourage flax planting, it was decided to propagate all the varieties on hand. The two first named varieties were planted on April the third, the "Royal" on a square which had for two years been cultivated with grape cuttings. To facilitate cultivation and irrigation, if necessary, the seed was planted in rows twelve inches apart. The development of this variety was astonishing. In less than two months it was in full bloom, and had almost reached its full size without receiving a drop of irrigation. The rainfall after planting was exceedingly scant. The "Russian," from Pskoff, was planted, half of it, the same day, the other a few days later, between rains. The ground on which it was planted was cultivated two years ago with flax, and last season with barley. The soil is a little more gravelly than that of the piece occupied by the "Royal." After a month it was found that it needed water, and it received two irrigations during its season of growth, but never became equal to the "Royal." The yield of the two varieties when harvested, July twentieth, was at the rate of five thousand six hundred and forty-six pounds per acre, total weight for the "Royal," and three thousand four hundred and twenty-two pounds per acre for the "Russian."

The following varieties were sown very late, May fourth and fifth, on a piece of ground formerly cultivated with small grains. The condition of the soil, on account of too much moisture, was cloddy and in poor tilth. The seed was planted in drills twelve inches apart. The result was as follows:

Variety.	Rate of Yield Per Acre, in pounds.	
	Straw.	Seed.
White Flowering, from France	4,092	1,276
Royal, from Germany	3,689	987
Russian, from Pskoff	3,381	884
Yellow Seeded	2,713	706

These yields, although small, must be accounted fair when the late planting and the condition of the soil are taken into consideration.

Cinchona.—In the last published report of this department is a full account of the attempts made to introduce the cinchona tree into various parts of the State. The results arrived at were rather negative. The conclusions obtained by me from these reports were, nevertheless, that there are localities in the State where this tree will flourish. I am happy to state that during my travels last fall I found on the hills of San Diego some luxuriantly growing red Peruvian bark trees, which the owner, Mr. W. W. Morrison, had received two years previously from Washington. As the red bark tree is considerably more tender than either *C. officinalis* or the hybrid, we are more firmly convinced than ever that this tree can be successfully grown in protected warm belts, in the southern part of the State. It must, also, be only in such localities as have but the slightest frosts; in places, for instance, where the chirimoya or custard apple will grow, or in places where the heliotrope would flourish the year round. In a number of southern coast counties, such places are to be found. In the University garden of economic plants, by means of artificial protection, we have brought specimens of *officinalis* and of hybrid cinchonas through in excellent condition, and hope to have some of them blooming before another year. If we succeed in producing seed, it will be possible to distribute the plants more liberally, and also to produce a hardier race. The largest hybrid measures six feet, with a crown three feet in diameter, and the trunk an inch through. It grew all winter, and continues to do so now. Of the *C. succirubra*, all but one have succumbed, and this does not seem promising. *C. calisaya* has been lost entirely, being too tender for this locality—even with most careful protection given it. On account of the cheapness of quinine it is doubtful whether the cinchona would repay the trouble of growing it here. The subjoined report from San Diego speaks for itself:

Mrs. W. W. Whitney, The Highlands, San Diego, September, 1885.—The cinchona tree received here in 1884 is three feet high, well branched, and of vigorous growth.

Officinal Rhubarb (Rheum officinalis), grown here from seeds imported through Vilmorin, Paris, has for the last year been cultivated with comparative success, though the soil, we have reason to believe, is not suited for it. This is, as nearly as we can determine, the East India rhubarb of commerce. We have also tried the species on a sandy loam in Santa Cruz Mountains, where it appears perfectly at home.

Another species, imported from Russia, under the name of *Rheum palmatum*, is said to be of a far more valuable kind. Like the former it does not flourish in the clayey land in the garden of economic plants, but at private gardens at San Mateo, on soil of a lighter character, we have found it doing remarkably well.

Still another importation *(Rheum undulatum)* has reached us from the botanical garden of Berlin. It is as yet too early to judge of the true nature of these two kinds, but we believe they will prove to be identical with the first mentioned variety.

Matricaria Chamomilla (German chamomile).—This renowned plant does well in the climate of Berkeley, seeding itself freely every year.

Anthemis nobilis, the so called Roman chamomile, is of easy cultivation. Unlike its German cousin it is a perennial plant, and if planted once will remain for many years.

Ipomea purga (Jalap).—This does well when once established in the ground. The vine has become stronger and stronger from year to year. The flower of this morning glory is of a violet purple, quite large, the tube long and the limb flattened.

BAMBOOS.

The various species of bamboos described in our report for 1882 have all increased in growth, and proved more or less fully their adaptability to our climate. Of all the kinds grown the Chinese kind is undoubtedly the most useful and vigorous, its canes developing with astonishing rapidity.

Next to this comes the *Arundinaria falcata*, but this species evidently requires more water, and prefers a moister atmosphere than the former. Reports from various places where it has been tried, as well as our own experience, indicates this difference between these two bamboos. The latter does well at Santa Barbara, where it was sent from here.

In many respects the *Thamnocalamus spathiflorus*, a Himalayan species, resembles the *A. falcata*. We regret that too young plants of this bamboo were distributed last year. It is difficult to grow them when young; and this we believe to be the reason of so few having been successful except in moist places. On the whole, we feel justified in saying that many kinds of bamboo will thrive to perfection in California, and that they deserve extensive trial.

In our last report we alluded to the extreme usefulness of these plants, and tried to demonstrate at the State Fair of 1885 that durable furniture might be manufactured from them, as well as many other useful things. We find the smaller canes of several kinds most admirably adapted for handles for fruit boxes, also for lining and strengthening of the same. In fact, one use begets another, and there is no doubt that, once introduced, there would be found plenty uses for them.

It is to be regretted that the nomenclature of these plants in this country is beset with so many difficulties. To get at the true names of a number of species has been my endeavor for the last two years, but the descriptions in scientific works are chiefly based on the flower, and as these do not appear before the plant acquires age, we are left to a guess until we can succeed in receiving authentic named specimens from some botanic garden in the tropics.

Concerning the success with bamboos in different parts of the State, we give the following extracts from correspondence:

Chas. Knust, Cloverdale, Sonoma County.—The bamboos have grown very slowly.

A. Gall, Stockton, San Joaquin County.—One of the bamboos I received died; the other is alive, but is not doing well. It grows very slowly, in spite of the care and water it has received.

J. Cunningham, Saratoga, Santa Clara County.—The bamboo grew but very little last year; this year the longest stalks are five feet in length.

J. Rastede, Orange, Los Angeles County.—The Indian bamboo (*Thamnocalamus*) was nearly dried out by delay on the railroad, but is still alive.

R. Wylie.—The Indian bamboo stood the winter well.

L. L. Guss, Wright's, Santa Clara County.—The small Indian bamboo (*Thamnocalamus*) received in 1884 has grown three feet.

J. C. Foster, Orland, Colusa County.—The bamboo (*Arundinaria falcata*) received January 10, 1884, is growing nicely. It is three and a half feet high and looks splendid.

W. Still, Sonoma.—The bamboo (*Thamnocalamus*) is thriving nicely and looks healthy.

Rolla Butcher, Santa Clara.—The bamboos have both done pretty well. The *Tadake* is a slender variety, growing fast. I was first discouraged by the growth of the *Metake*, but it is now getting larger, and larger canes; the last is nearly half an inch through.

Will. Haddox, El Monte, Los Angeles County.—The bamboo (*Thamnocalamus*) does not grow well. It grows very slowly and is fine and spindling. I imagine the alkali injures it.

George Hanly, Forestville, Sonoma County.—The *Arundinaria falcata* received in 1884 have grown finely. They have been watered twice a week during the summer, and their growth is remarkably strong. My soil is river bottom.

Quinoa—Chenopodium quinoa. In Bulletin No. 5 the importance of this plant to certain South American countries has been dwelt upon. The trial of this plant in this locality must be pronounced very unsatisfactory. The first year of their introduction, after often repeated trials, the seed failed to grow. As, however, Mr. Meek, the importer of the seed, produced plants in his garden in Oakland, the reason of this failure was clearly due to the damage the certain sack containing our seed had received on the journey. The following year seed was received again, and a small quantity grew. Later on a number of plants were brought by Mr. Meek from Oakland. They were raised in pots, and when four to five inches high, in the month of May, they were set out in a carefully prepared bed in the garden of economic plants. No sooner had the young plants been rooted to the soil before they commenced looking sickly. Close examination proved that larvæ of some fly was boring through the pith of the tender plants. Spraying with a strong solution of whale-oil soap stopped this after a number of plants had been killed, and the remaining ones rallied again, and by means of frequent watering with manure water assumed a healthy appearance. But hardly had this taken place before a new enemy was observed. It was found that the leaves withered up completely. Examination revealed a number of maggots of a fly feeding on the fleshy green part of the leaf from the inside, leaving only the epidermis. From four to ten bunches of eggs were deposited on the under side of the leaf, and through a hole made by the fly the larvæ evidently found their way. So numerous must these flies have been that in spite of the eggs being brushed off every morning hardly a plant reached any size, and none matured seed in this place. The larvæ were hatched in a bottle, and turned out to be a fly resembling very much in appearance a horsefly. Although the plants seem well adapted to the climate, the presence of the above named enemy seemed here at least to make the quinoa cultivation impossible. Of the plants brought by Mr. Meek a few were kept in large pots and had especial attention, and by extraordinary precaution some seed of these was saved. It is possible that if planted considerably earlier the quinoa might be made to mature seed, as the fly did not make its appearance before June. The fly is evidently a native, and is occasionally found on the wild pigweeds, but it showed itself extraordinarily partial to the quinoa, as it singled it out no matter where found. The case is a most interesting one to the naturalist, but most discouraging to quinoa culture.

In the season of 1886 another trial with the quinoa was made, this time with the seed saved here last year, both of a variety originally introduced from Germany, and the Peruvian variety. The two kinds developed very fast and made a good growth before the fly made its appearance. The German variety, which is smaller than the Peruvian, seemed to do better, and in spite of the attacks of the fly gave a large quantity of seed. The Peruvian variety grew much taller and was slower in maturing, still a fair amount of seed was also produced of this. A planting of six weeks later had nearly the same fate as the previous year, showing conclusively that early planting must be resorted to to make any kind of success of this plant.

Tea Plants—Thea bohea.—For several years the tea bush from China and Japan has been tried; shrubs transplanted from Japan; also shrubs grown from seeds planted here on the spot. The transplanted bushes,

contrary to our expectations, have developed during the past two years good foliage, and have completely recovered from their long trip across the ocean. The seedlings raised on the spot have grown better in proportion. Enough is seen from this experiment to show that tea can be grown quite well in this locality.

Mr. A. Chabot, of Oakland, who has tried tea growing on a large scale, has, by means of plentiful irrigation, successfully grown very fine tea bushes.

Mr. L. A. Gould, of Auburn, California, has for years past grown and prepared his own tea. His bushes are also from seed sown on the spot. Several other instances are known of tea having been successfully grown here. All this experience would seem to establish the fact that tea, under irrigation, might be successfully grown in many parts of the State. However, it is equally probable that unless a very high grade of tea could be produced it would be out of the question to compete against the Orient in this staple. For those desirous of having pure tea it is, nevertheless, interesting and gratifying to know that tea growing here is quite feasible.

Lemon Grass of India (Cymbopogon schœnanthus).—This remarkable plant possesses in its leaves a lemon-scented etherial oil that is distilled and, under the name of "grass oil," is exported from India. The lemon grass is, as it seems, hardy, even in the climate of Berkeley, although, like most other tropical grasses, of rather stunted growth when grown out doors. At the garden of Mrs. Ellwood Cooper, Ellwood, Santa Barbara, I found this grass flourishing, together with many tropical plants rarely met outside of a conservatory. I also found it at garden of H. C. Ford, Carpenteria, Santa Barbara County, and, judging from these observations, I am satisfied that it would be a success all along the coast of Southern California where a mild winter temperature prevails.

Physalis edulis or Ground Cherry.—It is also called "Cape Gooseberry." The ground cherries are solanaceous plants, bearing a fruit surrounded by the bladderlike calyx. The fruit is about the size of a small gooseberry, yellow or red, and of a pleasant sweet and sour taste, very fine for preserving. When ripe they drop off and remain uninjured on the ground for some time, being protected by the investing calyx.

Physalis edulis has been cultivated here for the first time last year. Seed was received from Riverside, in this State; also from South America. It has proved a rank, hardy grower, unaffected by any common insects, although sometimes injured, though not seriously, by an insect boring in the young twigs. Fruits are now (September) ripe and are produced in abundance, but they lack in flavor compared with that grown in warmer localities.

Physalis obscura, a native of the eastern States of U. S. It does generally well in this locality, but did not succeed so well last summer (1885).

Yam (Dioscorea batatas).—Raised from bulblets introduced from China. It is thoroughly adapted to the climate of Berkeley, in the summer making immense vines. It requires a deep soil, and the tubers take several years to develop to suitable size.

Pueraria Sieboldtii.—From the long, fleshy roots of this plant the Japanese prepare a very superior edible starch. The vine seems perfectly well adapted to this climate. It makes long canes, ten to fifteen feet in the season, climbing on trees, etc., and is on the whole worth further trial. Although blooming freely it does not seed here.

CAPER BUSH (*Capparis spinosa*).

Later experiments with this plant have proved fully our conclusions expressed in our last report, that the caper would be found well adapted to many portions of this State. It prefers a well-drained soil of sandy character. The following notes are taken from our correspondence:

Dr. J. Scholl, Los Angeles.—The caper bush is twenty inches high, with long branches. It is flowering and fruiting.

Kenton Stevens, Montecito, Santa Barbara County.—The two caper bushes sent me last year are doing nicely. Although it is perhaps premature to say so, I consider them a success.

A. E. Beckwith, Los Gatos, Santa Clara County.—The capers received this spring are doing finely, and have sent out several runners.

INSECT POWDER PLANTS.

Pyrethrum cinerariæfolium, and P. roseum.—There has been a constant demand for the seeds of these plants, and we have sent out a sufficient supply for testing to all applicants. The uses of the plants have been fully discussed in previous reports. The following notes are from correspondence with those who have grown plants from the University seed:

W. B. Atterbury, Santa Rosa, Sonoma County.—The insect powder plants have done well on poor dry soil without water.

S. G. Baker, Norwalk, Los Angeles County.—The insect powder plants you sent me are doing splendidly. The ants don't like it. It is death to the grain weevil. It only needs to be planted in moist soil, and there grows vigorously.

W. B. Fielding, Los Gatos, Santa Clara County.—I received the Dalmatian and Persian insect powder plants, six of each, in 1884, and they were planted in a soil consisting of decomposed sandstone and vegetable mold. They were irrigated three times, but grew very little. This season one of each, nearest to some irrigated beans, bloomed. The Dalmatian produced but twelve stocks, while the Persian yielded over one hundred and bloomed for two months.

A. B. Butler, Butte City, Colusa County.—The Dalmatian insect powder plant does well here, and can be grown with very little trouble.

THE UNIVERSITY ORCHARD.

The standard orchard of the College of Agriculture furnishes the most striking proof of the adaptation and non-adaptation of certain varieties of fruit to a given locality. In order to render them of more value to those unacquainted with the climate of this section, I shall preface my notes on the behavior of different varieties with a few remarks on the conditions of soil and climate under which the tests are made.

The climate of Berkeley is decidedly that of the coast counties around the bay, with less wind prevailing, however, than, for instance, in the southern portion of Alameda County and in San Mateo County. The rainfall is ample to enable fruit trees on good soil to do well without irrigation. The winters are mild, the thermometer seldom falling below 25 degrees Fahr. The early spring months are generally warmer and more conducive to growth than April and May. North winds are not very formidable

although sometimes of considerable violence. The summer temperature is very cool, often not higher than 65 degrees in the middle of the day; the sky is often overcast for many days in July and August, and heavy fogs occur at intervals. In consequence of these conditions, fruits, especially late blooming kinds, mature late.

As a general thing peaches do not do well, yet, when not ruined by curl-leaf, mature finely flavored fruit, although lacking in sweetness, and such varieties as Hale's Early can be depended upon for a fair crop almost every year.

Nectarines suffer, of course, from the same diseases as the peach, and those that do mature are of rather poor quality.

Of grapes, some of the earlier foreign kinds mature, although rather lacking in flavor, while certain American varieties, as the Diana, do well.

Outside of these three kinds of fruit (peaches, nectarines, and grapes), deciduous fruits can be grown to advantage if proper varieties are selected. Among the many varieties of apples, pears, plums, and apricots, we find many doing well, others less so, and a number altogether worthless. Some bear every year, some every other year, some every third year, and some only once in four years. To keep an exact record of such a large number of varieties (about five hundred) is a task requiring a vast amount of time and patience, in view also of the fact that results are sometimes interfered with by the untimely picking of the fruit by trespassers, who, in spite of close watching, sometimes manage to steal the best samples. By extending observations, however, several years, such accidents have less weight and trustworthy conclusions can be arrived at.

APRICOTS.

The following notes on apricots are the results of four years observations. They illustrate plainly the fact so well known to experienced growers, but too often overlooked by beginners, that to be successful in fruit growing one must know the adaptation of a variety to his conditions before going largely into planting it. There are instances of orchards in different parts of the State which have been cultivated for years without yielding any crop whatever long after the proper time for coming into bearing.

The apricot trees in the standard orchard were imported from the East and planted about ten years ago. The soil in which they grow is a heavy loam, varying in depth from six inches to eighteen inches, the subsoil being clay intermixed with rock. The exposure is that of a gentle slope to the south and east, except where interfered with by a shelter belt of acacia trees, which has recently been removed. The trees have grown well.

From the course of observation on the apricot varieties, they may be divided into four classes:

Class 1.—Varieties having proved adapted to the climate and yielding fruit in fair quantity:

Blenheim, or Shipley.—This has proved the best variety tried so far. The fruit is of medium size, weighing seven to the pound when properly thinned; oblong, pit small, color fine; ripens early; a short time after the Sardinian. In 1885 it ripened from July first to July tenth. The Blenheim commenced bearing the fourth year after planting. One tree in a comparatively good situation has for several years borne over two hundred pounds of fruit. The tree is vigorous and healthy.

Hemskirk.—A large dull colored apricot of excellent quality, and often weighing four to the pound. It resembles the Moorpark, but ripens more

evenly, and is a much more trustworthy bearer, having borne fair crops for several years in succession up to 1885, when there were but few. It has shown some tendency to crack a little on the sunny side. The tree is of stubby growth. The fruit ripens about two to three weeks later than the Blenheim.

Beauge.—Under this name we have cultivated a very handsome apricot of the Blenheim type. It is possible that the name is incorrect. The fruit is of a most beautiful color—golden yellow, painted with the brightest red. It ripens evenly, is of firm texture, rich quality, but a clingstone, and for this reason could probably only be recommended for shipping East. The tree is a moderate grower and a good bearer; the fruit of uniform size, about seven to the pound. It ripened in 1885 July eleventh.

Orange, or Royal (?).—We are not positive about this being identical with the Royal, cultivated so successfully over a large part of the State. It resembles it closely. Buds of the common Royal which have been put in will soon settle the question. The fruit is of much higher color than the Royal cultivated in the interior, but as the apricot grown here is, as a general rule, much better colored here than in the warmer parts of the State, this difference between the one we have uuder the name "Royal" and that commonly grown under that name would not be a sure distinction. Grown here the variety is rather dry and only a moderate grower, although bearing well and early.

Sardinian.—This little apricot is cultivated on account of its earliness; it seems here to be a little earlier than the Blenheim.

Class 2.—Varieties producing fine large fruit, and ripening evenly, but, so far, not yielding satisfactorily:

Large Alberge de Montgamet.—Fruit large; freestone; pits very readily; color orange; flesh very firm and rich. From the behavior of this apricot and the next one, St. Ambroise, we should judge that they would do better in a warmer climate.

St. Ambroise.—Also a large, fine looking apricot, which, like the preceding variety, so far has borne but little. The tree is large and vigorous.

The Moorpark.—This well known variety must also be classed here. It ripens unevenly.

Class 3.—The following varieties have been planted and grown under very unfavorable conditions, being all more or less affected by a windbreak of acacia trees. The acacias have been removed, and the apricot trees are improving. Some of the varieties are very promising, among which we name the following:

Kaisha.—A variety from Syria; medium sized; pale colored; a freestone of excellent flavor and quality; more juicy than any other apricot grown here.

Canino Grosso.—A fine, large apricot of the Hemskirk type; looks promising.

De Coulargе.—Also a fine, large apricot, resembling the Hemskirk very much in shape.

Class 4.—Varieties grown here for ten years, and apparently unsuited to the locality, having produced but little fruit: Early Golden, Breda, Red Masculine, Turkey, Malcolm Breda.

The Early Golden produced quite a large crop five years ago, but since that the tree has not borne ten pounds altogether.

OBSERVATIONS ON THE CHARACTERISTICS OF VARIETIES OF PEARS AND APPLES.

The observations embodied in the subjoined tables extend over a period from two to five years. Many of the varieties not recorded before the last two years bore fruit before, but only in small quantities, and were either damaged by birds or taken by intruders.

Where notes are made in regard to the bearing of trees the words *good bearer* means *good* in *proportion* to the size of the tree; and the actual product of some small growers, as Dana's Hovey (Winter Seckel) or Bonne du Puits Ansault, would be considered extremely small, for instance, for Howell or Conseiller de la Cour.

In the notes reference is made to some varieties as being unsatisfactory in ripening, and the idea is advanced that their failure may be due to unsuitable conditions. Further experiments in different localities and deeper soil can alone settle this question. Some of them have latent good qualities, which cannot be brought out in this locality.

Where remarks are made as regards fungus or blight reference is had to the peculiar smoky-looking fungus (*Fusicladium dendriticum*), causing scabby fruit, which of late has become very widespread, and in some localities must be regarded as dangerous as any insect injuries. In my report, as Inspector of Fruit Pests, this disease is fully discussed. Suffice it to say that there has been a marked difference in the various varieties of pears. This was especially apparent the first year the blight showed itself seriously. Gradually some varieties, at first free, became affected, and indeed few would probably remain entirely exempt in unfavorable seasons. Experiments to counteract its influence have been going on for several years, but not until this season (1886) did we succeed in checking it thoroughly. So far this disease has not extended to the apple trees in Berkeley. So there has been no opportunity to try the efficacy of the remedy on them; but as the disease affects both kinds alike, we feel confident of success with the apple tree also. The remedy, which was proposed by you, and which may be called sulphide whale-oil soap, was found most effective when prepared as follows:

Dissolve thirty pounds whale-oil soap (eighty per cent soap, at the most costing five cents per pound), in sixty gallons of water, by heating the two together thoroughly. Boil three pounds of lye (American concentrated lye is what we have used) with six pounds of sulphur and a couple of gallons of water. When thoroughly dissolved it is a dark-brown liquid (chemically, sulphide of soda). Mix the two (the soap and the sulphide of soda) well, and allow them to boil for about half an hour; then add about ninety gallons of water to the mixture, and it is ready for use. Apply it warm, at about 130°, by means of a spray pump. Used warm, its effect is better, and less material is required than when cold. We have found this wash also effectual in destroying several species of scale insects.

TABLE 3.

Summer Apples.

NAME OF VARIETY.	Habit of Growth.	Resistance to Disease.	Average Time of Picking.	Average Time of Ripening.	Average Yield.	Quality.	Keeping Quality.
Calville Rouge d'Eté	Small and slender		July 14	July 20	Small	Fair	Fair.
Grand Duke Constantine	Small	Subject to aphis; free from fungus	July 11	July 16	Fair	Good	Fair.
Cardinal	Fair; stout habit	Very healthy	July 20	August 1	Small	Good	Fair.
Red Astrachan	Fair	Subject to aphis; free from fungus	July 20	End of July	Good	Good	Good.
Duchess of Oldenburg	Small and slender	Very subject to aphis	July 24	End of July	Good for the size of tree	Fair	Good.
Garretson's Early	Small	Subject to aphis	July 23	End of July	Small	Good	Good.
Sweet June	Small and slender	Subject to aphis	July 23	End of July	Fair	Good	Good.
Count Orloff	Small	Subject to aphis	July 28	Beginning of Aug.	Small	Fair	Fair.
Kirkbridge White	Small	Subject to aphis	July 25	End of July	Good	Fair	Fair.
Keswick Codlin	Fair	Very subject to aphis; free from fungus	July 28	Beginning of Aug.	Very good	Fair	Good.
Summer Queen	Small	Subject to aphis	July 24	End of July	Very good; overbears	Fair	Fair.
Summer Rose	Small	Subject to aphis	Aug. 1	Beginning of Aug.	Very good; overbears	Fair	Fair.
Summer Hagloe	Fair	Subject to aphis	July 28	Beginning of Aug.	Good	Fair	Good.
Fanny	Fair	Subject to aphis	Aug. 10	Middle of August	Fair	Good	Good.
Early Harvest	Strong	Subject to aphis	Aug. 1	Beginning of Aug.	Small	Good	Fair.
Primate	Fair		Aug. 1	Beginning of Aug.	Small	Good	Good.
Gravenstein	Strong	Subject to aphis	Aug. 9	Middle of August	Small	Very good	Good.
Golden Sweet	Strong	Little subject to aphis	Aug. 25	End of August	Good	Good	Very good.
Hawthornden	Fair	Subject to aphis; free from fungus	Aug. 15	End of August	Good	Good	Good.
Pomme Royale or Dyers	Fair	Very little aphis; free from fungus	Aug. 15	End of August	Small	Good	Good.
Carolina Red June	Fair				Small	Good	Good.
Lowell	Fair		Aug. 16	End of August	Small	Good	Good.
Sherwood's Favorite	Good		Aug. 16	End of August	Fair	Good	Fair.
Porter	Fair	Little aphis; suffers from fungus	Aug. 16	End of August	Fair	Good	Good.

TABLE 4.

Fall Apples.

NAME OF VARIETY.	Habit of Growth.	Resistance to Disease.	Average Time of Picking.	Average Time of Ripening.	Average Yield.	Quality.	Keeping Quality.
Belmont	Fair	Very subject to aphis	August 24	Beginning of Sept.	Small	Fair	Good.
Skinner's Seedling	Strong	Subject to aphis; otherwise healthy	Sept. 9	Middle of September	Fair	Very good	Good.
Autumn Strawberry	Fair	Subject to aphis; free from fungus	Sept. 4	Middle of October	Fair	Good	Good.
Maiden's Blush	Fair	Subject to aphis	Sept. 4	End of September	Fair	Fair	Good.
Yopp's Favorite	Fair	Subject to aphis	Sept. 15	End of September	Fair	Good	Good.
Fall Jennetting	Good	Very little subject to aphis	Sept. 1	Middle of September	Fair	Fair	Fair.
Twenty Ounce	Small		Sept. 15	End of September	Fair	Fair	Good.
Smokehouse	Strong; spreading habit	Very little aphis; very healthy	Sept. 7	End of September	Good	Fair	Good.
Pumpkin Sweet	Strong	Subject to aphis	Sept. 13	End of September	Small	Fair	Fair.
Grimes' Golden Pippin	Fair		Sept. 6	Middle of September	Small	Good	Good.
Jersey Sweet	Fair	Very subject to aphis	Sept. 13	End of September	Fair	Fair	Fair.
Mangum	Fair	Subject to aphis	Sept. 13	Past middle of Sept.	Small	Fair	
Fall Wine	Good	Subject to aphis; free from fungus	Sept. 26	End of September	Small	Good	Good.
Disharoon	Strong	No aphis; very healthy	Sept. 25	Beginning of Dec.	Small	Good	Good.
Flower of Kent	Small		Sept. 4	Beginning of January	Small	Good	Good.

TABLE 5.

Late Fall and Winter Apples.

NAME OF VARIETY.	Habit of Growth.	Resistance to Disease.	Average Time of Picking.	Average Time of Ripening.	Average Yield.	Quality.	Keeping Quality.
Hall	Small and spreading	Very subject to aphis	Oct. 23	End of November	Fair for the size of tree	Good	Very good till April.
Nick-a-jack or Berry	Strong and spreading	Subject to aphis and fungus	Oct. 15	End of December	Fair	Fair	Very good till April.
Duckett	Fair and spreading	Little aphis; very healthy	Oct. 8	Beginning of Nov.	Good	Fair	Fair till January.
Equinitely	Fair and upright	Subject to aphis	Oct. 8	Beginning of Dec.	Good	Good	Fair till March.
Rome Beauty	Fair		Oct. 30	Beginning of Jan.	Small	Good	Very good till April.
Ortley or White Bellflower	Fair	Subject to aphis and fungus	Oct. 15	End of November	Good	Very good	Fair till January.
Wagener	Fair	Little subject to aphis	Oct. 15	End of November	Small	Good	Good till April.
White Pippin	Fair		Oct. 6	Beginning of Nov.	Small	Fair	Fair till January.
Seek-no-further (Connecticut)	Fair	Subject to aphis	Oct. 6	Beginning of Dec.	Small	Good	Good till February.
Swaar	Good	Little aphis, but not healthy	Oct. 22	Beginning of Dec.	Fair	Very good	Good till February.
Red Fall Pippin or Red Winter Pearmain	Fair	Little aphis, and very healthy	Oct. 19	End of December	Good	Very good	Very good till April.
Cogswell	Fair	Subject to aphis	Oct. 9	Middle of Dec.	Small	Good	Good till January.
Golden Russet (English)	Fair		Oct. 5	Middle of Nov.	Small	Good	Fair till December.
Dahlonega	Fair and upright		Oct. 25	Beginning of Jan.	Good	Good	Very good till April.
Rambo	Strong and spreading	Subject to aphis	Oct. 15	Beginning of Dec.	Small	Rather poor	Poor.
Vandevere	Strong	Little aphis, and very healthy	Oct. 1	End of November	Small		Good.
Green Sweeting	Fair and upright	Very subject to aphis; otherwise healthy	Oct. 20	End of December	Fair	Good	Good till April.
Tallman Sweet	Fair		Oct. 5	Beginning of Nov.	Small	Fair	Fair till December.
White Winter Pearmain	Strong	Little aphis; suffers from fungus	Oct. 25	Beginning of Jan.	Good	Good	Very good till March.
Smith's Cider	Strong	Free from aphis; subject to fungus	Oct. 9	End of December	Good	Good	Good till February.
Roxbury Russet	Strong and spreading	Subject to aphis; very healthy	Oct. 27	Middle of Nov.	Good	Good	Poor.
Dutch Mignonne	Fair	Subject to aphis	Oct. 5		Good	Good	Good till March or April.
Rhode Island Greening	Strong and spreading	Little subject to aphis	Sept. 30	End of November	Heavy bearer, but irregular	Good	Good till March.
Hubbardston's None-such	Strong	Very subject to aphis	Sept. 30	Beginning of Nov.	Small	Fair	Poor.
Ben. Davis'	Fair	Very subject to aphis; also to fungus	Oct. 7	Beginning of Dec.	Small	Good	Fair till February (shrinks).
Canada Reinette	Fair	Little subject to aphis; very healthy	Sept. 13	Beginning of Nov.	Fair	Good	Fair.
Esopus Spitzenburg	Good and upright	Little aphis; very healthy	Oct. 12	Beginning of Dec.	Small	Good	Fair till January
Baldwin	Fair	Little subject to aphis; healthy	Oct. 12	Beginning of Dec.	Small	Good	Good till February.
Yellow Bellflower	Strong	Subject to aphis; healthy	Oct. 15	Beginning of Nov.	Small	Good	Good till January.

TABLE 6.

Summer and Fall Pears.

NAME OF VARIETY.	Habit of Growth.	Resistance to Disease.	Average Time of Picking.	Average Time of Ripening.	Average Yield.	Quality.	Keeping Quality.
Courte Queue d'Autumne	Fair	Suffers from fungus	July 22	July 25	Fair	Fair	Good—about a week.
Madeleine	Strong	Very little affected	June 22	June 25	Small	Fair	Good.
Beurré Precoce	Small	Very healthy	July 15	July 20	Good	Fair	Good.
Bloodgood	Good	Healthy	July 20	July 23	Good	Fair	Poor.
Beurré Gifford	Good	Healthy	July 15	July 20	Fair	Fair	Fair.
Doyenne d'Eté	Small	Healthy	July 10	July 15	Fair	Fair	Fair.
Rostiezer	Good	Healthy	Aug. 3	Aug. 8	Small		
Petite Marguerite	Good	Healthy	Aug. 1	Aug. 5	Good	Fair	
Duchesse de Berry d'Eté	Fair		Aug. 5	Aug. 10	Small		
Brandywine	Good	Healthy	July 25	July 30	Good	Fair	Fair.
Anne Ogereau	Medium	Healthy	Aug. 3	Aug. 10	Fair	Fair	Good.
Clapp's Favorite	Good	Subject to fungus	Aug. 2	Aug. 9	Good	Good	Fair.
Brockworth Park, or Bonne d'Ezee	Fair	Very free from disease	Aug. 18	Aug. 25	Very good	Good	Excellent.
Beurré Gouboult	Very strong	Slightly affected by fungus	Aug. 5	Aug. 10	Very good	Fair	Good.
Duchesse Precoce	Fair	Very healthy	Aug. 15	Aug. 20	Good	Fair	Fair.
Canandaigua	Fair		Aug. 10	Aug. 18	Irregular	Variable	Fair; sometimes very gritty.
Souvenir du Congres	Good	Subject to fungus	Aug. 12	Aug. 18	Fair	Very good	Fair.
Beurre d' l' Assomption	Fair	Good	Aug. 15	Aug. 20	Good	Poor	Very poor.
Ananas d'Eté	Fair	Somewhat affected	Aug. 1	Aug. 6	Poor	Good	Fair.
Dearborn's Seedling	Strong	Good	Aug. 9	Aug. 14	Medium	Fair	Fair.
Bartlett	Good	Little affected	Aug. 25	Aug. 31	Fair	Fair	Fair.
Beau Present d'Artois	Small	Free from fungus	July 25	Aug. 1	Good	Poor	Very poor.
Edmunds	Strong	Slightly affected	Aug. 1	Aug. 6	Very good	Fair	Fair.
Ott	Small		July 23	July 30	Fair	Very good	Good.
Moyamensing	Strong		July 29	Aug. 5	Small	Good	
Jalousie Fontenay Vendèe	Fair	Free from fungus	Sept. 4	Sept. 11	Good	Fair	Fair.
Bonne Sophia	Very small	Much affected	Sept. 1	Sept. 6	Fair	Good	Good.
Madame Trevey	Small	Subject to fungus	Aug. 10	Aug. 18	Good	Good	Good.

Table 7.

Fall Pears.

Name of Variety.	Habit of Growth.	Resistance to Disease.	Av. Time Picking.	Av. Time Ripening.	Av. Yield.	Quality.	Keeping Quality.	Remarks.
Belle Lucrative	Strong	Free from fungus	Aug. 20	Aug. 25	Good	Good	Poor	Rots at the core.
Beurre Hardy	Good	Free from fungus	Aug. 30	Sept. 10	Fair	Good to v'y go'd.	Fair	Variable in quality.
Doyenne Boussock	Strong	Free from fungus	Sept. 4	Oct. 1	Good	Fair	Poor	Rots at the core.
Gratiola of Jersey	Good	Free from fungus	Aug. 25	Sept. 20	Good	Good	Fair.	
Nantais	Fair	Subject to fungus	Sept. 11	Sept. 18	Good	Poor	Poor	Rots badly at core.
De Tongres	Good	Slightly subject to fungus	Sept. 4	Oct. 1	Good	Good	Good	Very variable in time of ripening from year to year.
Stevens Genessee	Good	Free from fungus	Sept. 4	Sept. 30	Fair	Fair	Good.	
Calebasse Monstreuse	Poor	Free from fungus	Sept. 10	Oct. 1	Good	Fair	Fair	Good cooking pear.
Pratt	Small		July 30	Aug. 7	Small	Good	Fair.	
Andrews	Small		Sept. 4	Sept. 11	Good	Fair	Fair.	
Buffum	Fair	Free from fungus	Sept. 5	Sept. 10	Good	Poor	Fair	A very handsome pear.
Howell	Good	Subject to fungus	Sept. 11	Sept. 20	Good	Good	Good.	
St. Michael Archangel	Fair	Subject to fungus	Sept. 12	Sept. 30	Good	Good	Fair	Variable in quality.
White Doyenne	Fair	Free from fungus	Sept. 16	Oct. 1	Good	Fair	Good.	
André Desportes	Fair		Sept. 14	Oct. 2	Fair	Good	Good.	
Louise Bonne de Jersey	Fair	Slightly affected	Sept. 12	Oct. 1	Good	Good	Good.	
Swan's Orange or Onondaga	Fair	Free from fungus	Sept. 14	Oct. 3	Good	Fair to good	Good.	
Conseiller de la Cour	Very strong	Free from fungus	Sept. 23	Oct. 15	Good	Very good	Good.	
Maria Louisa D'Uccles	Small	Free from fungus	Sept. 20	Oct. 15	Good	Good	Good.	
Beurre Langlier	Fair		Oct. 6	Oct. 15	Fair	Fair	Fair.	
Bonne du Puits Ansault	Very small	Very subject to fungus	Aug. 30	Oct. 15	Fair	Very good	Fair	Fruit nearly cracked to pieces until 1886, when the sulphide of soda and soap mixture was used in spraying.
Doyenne Robin	Good	Free from fungus	Aug. 20	Oct. 30	Good	Fair	Good.	
Liberal	Fair		Sept. 1		Fair	Fair	Poor.	
Urbaniste	Good	Free from fungus	Sept. 3		Fair.			
Dr. Reeder	Small		Aug. 20	Sept. 1	Fair	Very good	Good	An excellent pear, coming very late into bearing; needs further observation as to yield.
Fulton	Fair		Aug. 30	Sept. 8	Fair	Good	Fair.	
Eugene Appert	Fair	Free from fungus	Aug. 19	Aug. 30	Small	Good.		
Oswego Beurre	Good	Slightly subject to fungus	Oct. 10	Oct. 18	Fair	Fair	Fair.	
Jones Seedling	Fair	Free from fungus	Sept. 24	Nov. 1	Good	Good	Fair	An excellent little pear, but varying in quality according to seasons.
Paradise d'Automne	Good	Free from fungus	Sept. 15	Sept. 25	Good	Very good	Poor.	
Seckel	Fair	Subject to fungus	Sept. 22	Sept. 30	Fair	Good	Poor.	
Rutter	Strong	Free from fungus	Sept. 12	Sept. 17	Very good	Fair	Good	Has borne well every year for six years.
Henry IV	Fair	Very subject to fungus	Sept. 20	Oct. 1	Good	Good	Fair.	
Beurre Superfin	Fair		Sept. 11	Sept. 30	Small	Very good	Fair.	
Duchess d'Angouleme	Small	Subject to fungus	Sept. 12	Sept. 30	Small	Fair	Poor.	
Flemish Beauty	Fair	Slightly subject to fungus	Sept. 15	Sept. 22	Fair	Fair to good	Fair.	
Maurice Desportes	Small	Subject to fungus	Oct. 5	Oct. 17	Small	Good	Good.	
Beurre Bosc	Strong	Slightly subject to fungus	Sept. 19	Oct. 20	Small	Very good	Fair.	
Lawrence	Strong		Sept. 22	Oct. 30	Fair	Fair.		
Duchesse d'Orleans	Strong	Free from fungus	Sept. 17	Sept. 30	Good	Fair to good	Fair.	
Sheldon	Fair	Free from fungus	Sept. 25	Oct. 15	Good	Good	Good.	
Nouveau Poiteau	Good	Subject to fungus	Sept. 20.					
Beurre de Waterloo	Fair	Subject to fungus	Sept. 14	Sept. 30	Fair	Fair	Fair	Very handsome shape, bright yellow and red.

TABLE 8.

Winter Pears.

NAME OF VARIETY.	Habit of Growth.	Resistance to Disease.	Av. Time Picking.	Av. Time Ripening.	Av. Yield.	Quality.	Keeping Quality.	REMARKS.
Beurre Diehl	Fair	Not subject to fungus	Sept. 5	Dec. 1	Fair	Good	Good.	
Barronne de Mello	Fair	Not subject to fungus	Sept. 4	Nov. 1	Good	Irregular	Good.	
Duhamel de Monceau	Poor	Not subject to fungus	Oct. 4	Nov. 30	Good	Very good	Good.	
Doyenne Sieulle	Fair	Subject to fungus	Oct. 7	Dec. 1	Good	Very good	Good.	
St. Germain	Good	Subject to fungus	Oct. 5	Dec. 30	Very good	Very good	Good	Kept till April.
Duchesse de Bourdeau	Poor	Free from fungus	Oct. 4	April 1	Good	Good	Good	Owing to dryness in our soil, this fruit drops, and has to be picked before perfectly matured.
Epine Dumas	Poor	Subject to fungus	Oct. 15	Nov. 1	Good	Good	Fair.	
Passe Colmar	Fair		Oct. 4	Dec. 1	Small	Good	Good.	
Fondante de Noel	Fair	Subject to fungus	Oct. 6	Dec. 30	Good	Good	Good.	
Figue d'Alencon	Fair	Subject to fungus	Oct. 6	Nov. 15	Fair	Very good	Good	Quality rather irregular, and trees delicate.
Mt. Vernon	Fair	Not much affected	Oct. 1	Nov. 1	Small	Very good	Fair.	
Beurre d'Anjou	Fair	Somewhat affected	Oct. 1	Nov. 30	Fair	Good	Fair.	
Beurre Amande	Fair	Free from fungus	Oct. 5	Nov. 1	Good	Fair	Poor.	
Dana's Hovey	Very small	Subject to fungus	Oct. 1	Nov. 1	Small	Very good	Very good.	
Beurre d'Aremberg	Good	Subject to fungus	Sept. 26	Jan. 1	Good	Good	Poor.	
Beurre Clairgeau	Fair	Free from fungus	Sept. 20	Dec. 1	Fair	Fair	Good.	
Pitmastons Duchess d'Angouleme	Strong	Free from fungus	Sept. 14	Oct. 15	Small	Good	Good.	
Beurre Langlier	Strong	Subject to fungus	Oct. 14	Dec. 15	Fair	Fair	Poor.	
Emil d'Heyst	Fair	Subject to fungus	Sept. 30	Nov. 25	Good	Good	Fair	Irregular in quality and time of ripening.
Vicar of Winkfield	Strong	Very healthy	Oct. 5	Jan. 1	Good	Fair	Good.	
Benrre Gris Nouveau d'Hivre	Fair	Subject to fungus	Oct. 15	Nov. 30	Good	Good	Good.	
Madam Loriol de Barney	Fair	Free from fungus	Oct. 2	Dec. 1	Good	Good	Good	Very stout grower.
Augustus Dana	Strong	Free from fungus	Sept. 30	Oct. 31	Small	Very good	Good	Promising pear if it proves a good bearer.
Napoleon the Third	Strong	Very subject to fungus	Oct. 6	Feb. 15	Good	Good	Very good	Tree marked by thorny branches; needs a longer growing situation than in our unfavorable conditions.
Bergamot d'Esperen	Fair		Oct. 11	Feb. 15	Good	Fair	Good.	Very sweet, but lacking in character.
Josephine de Malines	Fair		Oct. 15	Jan. 1	Small	Very good	Good.	Variable in time of ripening.
Jaminette	Fair	Slightly subject to fungus	Oct. 6	Dec. 15	Good	Fairly good.	Good	Large pear, resembling Clairgeau in appearance; never thoroughly ripens here, and is apt to drop prematurely.
Inconnue Van Mons	Fair	Subject to fungus	Oct. 15	Feb. 1	Good	Good	Good	Like Vilmorin, seems not adapted to our situations; should be tried elsewhere.
Louis Vilmorin	Small	Generally free from fungus.	Sept. 15		Fair			Same as Duchess de Mouchy; perhaps worse.
America	Strong	Free from fungus	Oct. 6	Nov. 1	Small	Fair.		Drops prematurely; large fruit; not satisfactorily tested so far; comes in bearing very late.
Doyenne de Comice	Fair	Suffers from fungus	Oct. 10	Nov. 1	Small	Good.		
Duchess de Mouchy	Small	Free from fungus	Oct. 12		Good			
Bergamot Cadet	Fair	Subject to fungus	Oct. 10	Dec. 1	Good	Good	Good.	
Marschal Vailliant	Good	Free from fungus	Oct. 11		Small			
King Sessing	Good	Subject to fungus	Oct. 18	Nov. 6	Small	Fair	Poor.	
Belle Williams	Good	Free from fungus	Oct. 2	Oct. 25	Small			
Doyenne d'Alencon	Good	Free from fungus	Oct. 10	Jan. 1	Fair	Good	Good.	
Princess St. Germain	Small	Subject to fungus	Oct. 11		Small			Same as Duchess de Mouchy.
Winter Nelis	Fair	Subject to fungus	Oct. 15	Dec. 1	Small	Good	Good.	

APPENDIX IV.

REPORT ON INSTRUCTION GIVEN IN ECONOMIC ENTOMOLOGY, EXPERIMENTS CONDUCTED, ETC.

By E. J. Wickson, Lecturer on Practical Agriculture, and Assistant Superintendent of Agricultural Grounds.

Professor E. W. Hilgard:

Sir: I herewith submit a report on Economic Entomology.

Respectfully,

E. J. WICKSON.

Instruction in Elementary and Economic Entomology has been given during the year to a class of regular and special students. This work was undertaken by my predecessor, Mr. C. H. Dwinelle, in connection with the Lectureship on Practical Agriculture, because of the pressing need of such information by those engaged in or contemplating enlistment in orchard industries, and in the hope that a fully equipped chair of Economic Entomology would ere long be provided for in the College of Agriculture. The present incumbent has carried on the work with the same end in view, and the experience of the year, both in the interest manifested in the subject by the students and in the constant receipt of insects for determination and inquiries concerning the destruction of pests, convinces me that this is a matter in which the agricultural interest of the State stands in imperative need. The University, with its excellent facilities for both outdoor and laboratory experimentation and observation, and its full equipment for chemical research, which must be employed largely in the investigation and preparation of insecticides, seems especially fit to answer the popular requirement for a competent source of information and advice on matters involved in Economic Entomology. Even with the best system of laws to secure proper disinfection, and the most careful and competent officers for the inspection of orchards, and enforcement of laws of repression and quarantine, there still remains the need of a Bureau of Economic Entomology, to which both the State officers and the individual growers can go for consultation, information, and advice. The people naturally look to the State University for this aid, and it should certainly be provided for.

The instruction during the past year has been by the use of text-books, by lectures, and by outdoor studies in field and orchard. Students have been brought into immediate contact with the work, in preparation and handling of the washes used in the orchard, and the application of the same. They have made examinations to test the efficacy of the treatment, etc. These exercises, in connection with studies of the large numbers of pests sent in for identification and information, has brought students to a

practical knowledge of many of the insects which are now giving most trouble in different parts of the State.

THE HESSIAN FLY AND RESISTANT GRAINS.

The most extensive experiment conducted during the year was to determine, if possible, whether some varieties of wheat and barley would resist the attacks of the Hessian fly (*Cecidomyia destructor*). The results of this investigation were first made public in Bulletin No. 58 of the University Agricultural Experiment Station, issued October 9, 1886. In the following account of the work some portions of that earlier publication will be incorporated:

The Hessian fly (*Cecidomyia destructor*) appeared in the grain growing on the experimental grounds of the University of California in the spring of 1885. The visitation was so serious that it vitiated a number of experiments which were under way to ascertain the comparative values of different methods of culture and the appplication of different fertilizers. At the same time it was noticed that the work of the pests was much more destructive on some varieties of wheat than others, and it was decided to make the best possible use of the infested fields by a careful experiment in the season of 1886 to ascertain if any varieties could be found to be practically resistant; as it is claimed certain varieties are resistant in the infested districts of the Eastern States. The experiment, owing to the peculiar character of the season, was conducted in such a way as to give the fullest advantage to the insect and the greatest disadvantage to the grain. The plots were sold late (February twenty-fifth) and no doubt some of the varieties experimented with were ruined, which would have only been partially destroyed had they been earlier sown, and thus have reached a more advanced condition when the fly appeared. It is, however, quite as well, perhaps, because it made the test very severe, and the more useful, since, in the counties most afflicted by this pest, it is very often necessary to sow grain late because of the danger of water-killing during heavy winters.

Seed was taken from the collection which has been secured with much care from different grain-growing countries of the world. There were in all one hundred and seventy plots sown, with upward of one hundred varieties of wheat, twenty-five barleys, thirty-five oats, and the balance ryes. The grain was sown in drills, was well cultivated, and given every chance to make a good growth. The soil is the upland adobe, somewhat ameliorated by application of lime and other fertilizers during previous years. Careful notes were taken of the behavior of each variety, and frequent examinations made to ascertain the presence of the fly, both in the larval and the "flaxseed" stages.

The following tables present the records of the experiment with barley and rye in condensed form:

TABLE 9. BEHAVIOR OF CERTAIN WHEAT VARIETIES WHEN ATTACKED BY THE HESSIAN FLY.

VARIETY OF WHEAT.	Harvested.	Crop.	Remarks.
Austrian	July 29	One quarter	Badly infested with fly.
Common White Bearded Spelt	July 19	One half	Badly infested with fly.
Archer's Prolific		Small crop	A few flaxseeds found.
North Allerton			Killed. Badly infested.
Blood Red			Killed. Badly infested.
Bohemian			Killed. Badly infested.
White Bearded Spelt	July 28	Fair crop	Some flaxseeds found.
White Banate	July 19	Very poor	Badly infested.
Bearded wheat from Missoyen	July 19	Small crop	No traces of fly found.
Centennial Black			Nearly destroyed.
White Chaff			Killed.
Chiddam			Killed.
Champlain	July 19	Small crop	Badly infested.
California Spring	July 19	Very poor	Badly infested.
Common March	July 19	Fair crop	Few flaxseeds in fourth joint.
White Flanders			Killed.
Frankensteiner	July 28	Fair crop	Somewhat infested.
Golden Drop			Killed.
Silesian Spelt	July 19	Fair crop	Somewhat infested.
Hungarian (Brenner)	July 28	Poor crop	Somewhat infested.
Hungarian (Erfurt)	July 19	Fair crop	Somewhat infested.
Hallet Original Red			Killed.
Improved Circassian	July 19	Fair crop	Somewhat infested.
Red Emmer	July 19	Poor crop	Somewhat infested.
Nonette Lousanne	July 19	Fair crop	Few flaxseeds in fourth joint.
Prince Albert			Killed.
Polish	July 19	Fair crop	Somewhat infested.
Palestine	July 13	Fair crop	No flaxseeds found.
Black Emmer			Killed.
Petali	July 13	Fair crop	Not infested.
Probstein			Killed.
Paine's Defiance			Killed.
Rye Wheat	July 28	Fair crop	Somewhat infested.
White Russian			Killed.
Red Club	July 19	Fair crop	Slightly infested.
Red Bearded	July 12	Fair crop	Somewhat infested.
Spaulding's Prolific	July 28	Very poor	Badly infested.
Smoggi			Killed.
Square Sicilian	July 13	Very poor	Badly infested.
Tunisian	July 28	Very poor	Badly infested.
Thuringian	July 28	Fair crop	Badly infested.
Volo	July 12	Good crop	Not infested.
White Velvet			Killed.
Victor	July 19	Poor crop	Somewhat infested.
Whittington	July 13	Small crop	Somewhat infested.
White Sonora	July 28	Failure	Badly infested.
White Emmer	July 28	Very poor	Badly infested.
Yellow Noe	July 19	Small crop	Badly infested.
Zealand			Killed.
Nonpareil	July 13	Poor crop	Somewhat infested.
Black Bearded Macaroni	July 19	Fair crop	Somewhat infested.
Chile	July 28	Very poor	Badly infested.
Washington Glass		Almost failure.	No fly found.
Arnold's Gold Medal		Almost failure.	Badly infested.
Clawson	July 28	Very poor	Badly infested.
Brown Spelt		Very poor	Badly infested.
Winter (Rickenbrode)		Failure	No trace of fly found.
Forelle	July 28	Fair crop	Not infested.
Fultz	July 28	Failure	Somewhat infested.
Red Chaff (Burke)	July 28	Poor	Badly infested.
Blue Bearded Spelt	July 28	Fair crop	Quite fully infested.
Big White Club	July 28	Very poor	Badly infested.
Touselle	July 28	Very poor	Badly infested.
Sicilian (Brenner)	July 28	Very poor	Badly infested.
Odessa	July 28	Very poor	Badly infested.
Beardless Velvet	July 28	Very poor	Badly infested.
Dinkel Spelt	July 28	Very poor	Badly infested.
Jonquill	July 28	Very poor	Badly infested.
Royal Australian	July 28	Very poor	Badly infested.

TABLE 9—Continued.

VARIETY OF WHEAT.	Harvested.	Crop.	Remarks.
Hallet's Genealogical			Killed.
Arizona Indian	July 28	Very poor	Badly infested.
Egyptian	July 28	No gr. in heads	Badly infested.
Red Sea		Failure	Badly infested.
Little Club	July 19	Very poor	Badly infested.
Hungarian (Burke)	July 28	Poor	Somewhat infested.
Red Sonora	July 13	Fair	Somewhat infested.
Mammoth (Oregon)	July 28	Very poor	Badly infested.
Big White Club (Oregon)	July 28	Poor	Abundantly infested.
Defiance (Pringle's)	July 28	Very poor	Abundantly infested.
Michigan Mixed	July 28	Poor	Abundantly infested.
Pringle's Best	July 28	Poor	Abundantly infested.
Mold's Red		Failure	Abundantly infested.
Mold's White		Failure	Abundantly infested.
White Pearl		Failure	Abundantly infested.
Winter Martin's Amber		Failure	Abundantly infested.
Diehl's Mediterranean		Failure	Abundantly infested.
Genoese (Winter)	July 28	Fair crop	Slightly infested.
McGehee's White (Winter)		Failure	Abundantly infested.
Extra Early Oakley		Failure	Abundantly infested.
Indian White (Winter)		Very poor	Abundantly infested.
Harris	July 28	Poor	Abundantly infested.
Blue Glass	July 19	Fair crop	Few flaxseeds in upper joints.
Velvet Bearded		Failure	Badly infested.
Short-beard Club		No grs. in head	Badly infested.
Big Long-bearded Club	July 19	Fair crop	Somewhat infested.
White Llama		Failure	Badly infested.
Brown Bearded		Failure	Badly infested.
Cujavian		Failure	Badly infested.
White Essex		Failure	Badly infested.
Velvet		Failure	Badly infested.

TABLE 10. BEHAVIOR OF CERTAIN BARLEY VARIETIES WHEN ATTACKED BY THE HESSIAN FLY.

VARIETY OF BARLEY.	Harvested.	Crop.	Remarks.
White Australian	June 29	Fair	Largely infested.
Annate	July 3	Fair	Somewhat infested.
Earliest Black (two-rowed)	June 22	Fair	
Small Blue Naked	June 29	Good	Somewhat infested.
Gugmalaya	June 22	Fair	No trace of fly.
Thuringian	July 19	Good	Somewhat infested.
Manchurian	June 22	Good	No trace of fly.
Large Naked (two-rowed)	June 29	Fair	Few flaxseeds in later growth.
Peacock	July 3	Good	Somewhat infested.
Black Spring	June 22	Fair	Slightly infested.
Four-rowed Spring	June 22	Good	Slightly infested.
Italian	June 29	Fair	Slightly infested.
Hallet's Pedigree Chevalier	June 29	Fair	Slightly infested.
Six-rowed (Brenner)	July 13	Very poor	Badly infested.
Six-rowed (Erfurt)	June 29	Poor	Somewhat infested.
Six-rowed Winter	July 12	Failure	Somewhat infested.
Nepaul		Failure	
Kalina	June 22	Fair	
Four-rowed Black	July 19	Fair	No trace of fly found.
Palestine	July 6	Fair	
Chevalier (Dep't of Agriculture)	July 12	Poor	
Six-rowed Black	July 13	Fair	Not infested.
Carter's Prolific	July 12	Fair	Somewhat infested.
Rice	July 12	Poor	Badly infested.
Blue	June 29	Fair	No trace of fly.

TABLE 11. BEHAVIOR OF CERTAIN RYE VARIETIES WHEN ATTACKED BY THE HESSIAN FLY.

VARIETY OF RYE.	Harvested.	Crop.	Remarks.
Spanish Double Bearing		Fair	Somewhat infested.
Saxon		Failure	
Russian			Killed.
Alpine			Killed.
Giant			Killed.
Hessian Bodyguard		Nearly failed	
Large Roman			Killed.
Perennial Champion			Killed.
Banater			Killed.
Hungarian	July 28		
Multiplying No. 11			
St. John's Day		Very poor	No fly found.
Swedish Land		Very poor	

The foregoing table shows that of the one hundred varieties of wheat sown, about twenty-five were destroyed. The plant was so weakened that no effort was made to throw out heads, and the stems were found to harbor in some cases as many as thirty larvæ and "flaxseeds." About thirty-five other varieties made a little better struggle and bore a few heads of grain, although in all cases the stems were found to be infested. About twenty varieties bore a fair crop of grain, although in all cases there were insects found on the stems; sometimes but few, and they in the upper joints (as high as the fourth), and in others quite a number were found. Of the whole collection there were but six varieties in which no larva or pupa of the fly were found, and they were as follows:

1. Bearded wheat from Missoyen.
2. Palestine.
3. Petali.
4. Volo.
5. Greek wheat from Atlanti.
6. Forelle.

These wheats all have solid stems, the straw being filled with pith. They all belong to the *hard* wheat type (*Triticum durum*), having rather long pointed grains, almost translucent, and a horny consistency, owing to their richness in gluten, though when grown in this State they rapidly change in this respect and become starchy. These wheats are chiefly grown in the countries bordering upon the Mediterranean and the Black Sea. They do not succeed in the north of Europe, nor are they of much account even in the middle of France. They are, however, quite hardy and productive in California, and with the change in their character noted above promise to be of considerable value.

Besides the above experiment in which the large grain collection was used, as described above, there were larger areas sown on January eighth, with those varieties which had been observed as resisting the fly during the experiments of 1885, with the following result:

Variety.	Rate of Yield per Acre—bush.
Volo	31¾
Bearded Missoyen	39½
Greek Atlanti	9¾

The seed of the last variety, Greek Atlanti, was very old, being taken from the museum specimen, and it was therefore slow in germination, weak in growth, and deficient in yield. It showed, however, its immunity from the fly, as none could be discovered by repeated examination. Now that fresh seed has been secured, it may be expected to yield as well as the others named above, which it closely resembles. These three wheats are of Greek origin. Samples of the grain were submitted to experts in milling and shipping wheats and pronounced good, merchantable wheat, and salable in the market at about two and one half cents per cental less than No. 1 shipping wheat. As they are naturally of strong growth and productive, it is expected that they will be found valuable in those localities where other varieties are rendered unprofitable because of the Hessian fly, and there will be small lots of the seed furnished to those who desire to experiment with them in fields known to be infested with the fly. Their success, both when sown on January eighth and on February twenty-fifth, shows that their immunity from the fly was in some peculiarity of their own and not in the time of sowing. The soil on which they were grown during the experiment here is quite poor and intractable, and better yields may be expected in more favorable situations.

It is a matter of some importance to determine whether a time for sowing can be selected so as to successfully circumvent the fly. In our own experiments it appears that Pringle's Defiance wheat sown on January eighth made a good growth, and bore at the rate of eleven and a half bushels per acre although attacked by the fly, while the same variety sown February twenty-fifth was practically a failure. The same was true of Nepaul barley, which, sown January eighth, yielded at the rate of twenty bushels to the acre, while that sown on February twenty-fifth was destroyed. On some lands now infested by Hessian fly it is impracticable to sow grain until the heavy water of winter has disappeared from the soil, and it is, therefore, of more importance to have a variety which will succeed at any time of sowing than to have a safe time of sowing determined upon, which will come when the land is seldom in condition to receive the seed.

We expect during the coming season to repeat some parts, at least, of our experiments, to determine the fly resisting ability of different wheat varieties, and also to secure testimony from our correspondents who will conduct experiments in other districts infested by the fly. We have a decided advantage in this work in California, because we can grow wheats from all latitudes.

The barleys grown beside the wheats seemed much less vulnerable to the attacks of the fly. Of the twenty-five varieties sown, about twenty bore from fair to good crops, although in most cases the larvæ and pupæ of the fly were found on the stems—sometimes few, sometimes many. Some escaped the fly entirely: the Guymalaya, a dark naked grain; the Manchurian, a small white grain; the Four-rowed black and the Six-rowed black, had no traces of the fly. The Large Naked Two-rowed had a few flaxseeds in the upper nodes. On the other hand, other varieties were nearly destroyed.

The ryes were generally a failure in this year's sowings—in some cases traceable to the fly, but generally the result of some other unfavorable conditions. There was no trace of the fly found in the oats.

The Hessian fly has but recently been demonstrated to have secured a lodgment in California, and its ravages have thus far been confined to valleys adjacent to the San Francisco Bay and its tributaries. It is a question how far its area may extend, but it is highly doubtful if it can thrive

in the dry and hot interior valleys. It has been claimed that the practice of burning off the stubble is to be credited with the long freedom of California from the pest. Such practice is certainly to be commended as at least likely to reduce the infliction. In badly infested localities this will not, however, accomplish the dislodgment of the insect, and it may be that the growing of resistant varieties will be of great advantage.

Resistant Varieties Here and Elsewhere.—In Bulletin No. 4 of the United States Entomological Commission, Dr. Packard gives a comprehensive compilation of existing knowledge on the Hessian fly. Concerning the resisting power of certain wheat varieties, it is shown that the "Underhill variety has for nearly a century been highly recommended." Dr. Fitch, State Entomologist of New York, stated that its fly-proof qualities were supposed to be due to the hardness or solidity of its straw. The fly laid its eggs freely upon the leaves, but it was seldom, if ever, materially injured by it. Throughout the Middle States a so called "Mediterranean wheat" has long been in high repute for its fly-proof and hardy nature. In this district the "Lancaster," also a red variety, has been claimed for years to have been exempt from the fly. In Michigan the "Clawson" has become famous as a fly-proof wheat, and red varieties generally have done well in this direction. The records in the table of results in the University experiments on a preceding page show that some varieties claimed to be resistant east of the Mississippi were so badly infested here as to be a failure. Such varieties are the Fultz and Molds Red. The Clawson, which is so highly praised in Michigan, is looked upon as a failure in New York, and in the University experiment the Clawson is recorded as "badly infested." This would seem to indicate that there is something in local conditions of growth, etc., as well as in the characteristics of a variety.

In the Pacific Rural Press of November 27, 1886, is a statement by Mr. A. V. Moore, of Tulare City, California. He was a mill owner and merchant in Michigan, and participated in the introduction in that State of what was termed "Michigan Amber wheat." In 1838 he obtained, from a distant friend, a pint of Mediterranean wheat, and after sowing it several years, and grinding it in their mill, he and his brother concluded it would be a disadvantage to have it grown by farmers in the vicinity, as the flour was not so white as some other kinds. But when it was finally found to be exempt from destruction by the Hessian fly, they sold it rapidly and profitably at double the price of ordinary seed wheat. A gradual but decidedly favorable change in its character and productiveness came with its repeated reproduction, and, so far as Mr. Moore is informed, it remained uninjured by the destructive fly.

An interesting instance of a resisting wheat in this State was drawn out by the early publication of the results of the University experiments in October last, as described in the following letter:

San Francisco, October 15, 1886.

E. J. Wickson, *University of California, Berkeley:*

Dear Sir: Your Bulletin, No. 58, duly received, and I send you to-day a sample of bearded wheat, which was claimed to be a Russian wheat and resistant to the Hessian fly. I have had very good results with it, and now have on hand a large quantity for seeding this fall. The stalk was not in the least affected by the fly, while in an adjoining field, where I had sown White Australian, I lost considerable by the insect, although it has not been so injurious in my section (San Mateo) as in others. Will you please tell me the name of the variety of the sample I send you? Unfortunately I did not retain any of the stalks or heads.

Yours respectfully,

FRANK H. BURKE.

The wheat resembles, in some respects, the Odessa, but without straw or beard the variety could not be definitely determined. We shall sow Mr. Burke's wheat beside our own resisting varieties this year and note the results in a subsequent report.

The Hessian Fly and the Grain Aphis.—The summer of 1886 was marked by an unusually wide visitation of the aphis or louse (aphis avenæ) in the grain fields of the State, and our correspondence showed that this insect was quite commonly mistaken for the Hessian fly. The grain aphis was quite fully described by Mr. Dwinelle, in the College of Agriculture report for 1884 (page 83), and engravings given of the aphis and of some of its most active foes. Referring those seeking information on the aphis to that publication, which will be sent to all who apply, it may be further said that a distinction between the aphis and the Hessian fly can be coarsely made in this way: The Hessian fly does not appear congregated in great numbers upon the growing grain. When it is abundant it may be seen, especially in the morning and evening, hovering over the wheat fields in vast numbers. The fly merely descends upon the plant to deposit its egg. It is exceedingly small, its whole length being but about one tenth of an inch. On the other hand, the grain aphis is found collected in vast numbers on the grain, generally near the base of the stem, some individuals having wings, but the greater number wingless. The Hessian fly always has wings, except in the larval state, when it is a white, semi-translucent maggot, rather spindle shaped, and about one sixth of an inch in length. Under its transparent skin may be seen greenish stripes extending around the body. This maggot changes when mature into a bright chestnut color. When in this state it much resembles a flaxseed, and the recognition of these "flaxseeds" wedged in between the leaf and the stem, near the joints, is demonstration that the grain is infested with the Hessian fly. There are other whitish maggots infesting the stems of grain, but they do not assume a likeness to a flaxseed.

Specimens of aphis-infested grain were received from many parts of the State. There was an invasion in some parts of Tulare County, which threatened great injury, but the insect was apparently destroyed by heavy rains which fell in this region in April.

An interesting case was that submitted by Charles M. Stetson, a graduate of the University, class of 1878. Mr. Stetson sent heads of Egyptian corn (dhoura), with the statement that the heads were infested with "insects and a gummy substance," and said that of seventy head of cattle turned into the field eleven died within an hour. The samples were seen to be badly infested with the grain aphis, and the "gummy substance" was the honey dew which the insects exuded. There were also upon the heads large numbers of larvæ of one of the syrphus flies. The samples were carefully tested for poison, but none was found. This left the surmise that perhaps the great numbers of insects eaten with the heads may have wrought some injury to the cattle, but it was impossible to verify or disprove it.

The Hessian Fly and the Joint Worm.—There have been samples of grain straw infested with the joint worm *(Isosoma tritici)*, sent to us under the impression that the maggot was the larva of the Hessian fly. The joint worm larva forms a gall or swelling of the wheat stem, near the joint, and lives therein. The Hessian fly larva nestles between the blade and the stem, and produces no marked swelling, although there is sometimes an enlargement or crowding out of the blade, when the larvæ are numerous

at one point. The best test of the presence of the Hessian fly is the finding of the "flaxseed" puparium, as the joint worm larva does not assume that form.

THE WOOLLY APHIS AND ITS REPRESSION.

Concerning the experiments made in the University orchard to reduce the *woolly aphis*, the following Bulletin No. 55 of the University Experiment Station was issued on May 6, 1886:

Among the many diseases to which the apple tree is subject, none is as persistent and hard to eradicate and more widespread than the woolly aphis, *Schizoneura lanigera*. The home of this pest seems to be obscure. In England it is supposed to have come from America, and there it goes under the name of American apple blight. It is found in France and Germany, and wherever met is regarded as one of the most formidable of pests. The Chilian Consul of San Francisco stated several years ago that in Chili it had destroyed whole forests of the wild apple.

It seems almost unnecessary to describe this pest, unfortunately so common, yet a few words to novices in horticulture will not be out of place. In form the woolly aphis resembles closely the green aphis, so common on roses and other plants, but its color is reddish brown, and when crushed it yields a red juice, hence the German name *Blutlaus*, or blood louse. The insects are always surrounded by a whitish woolly substance, hence the name "woolly" aphis. Like all aphides, this species increases with astonishing rapidity, and only a few need be left on a tree, to soon spread all over it. While the presence of the woolly aphis makes itself so conspicuous above ground, on the branches, covering them as if with snow, yet the most serious trouble lies out of sight, at the roots, which in our dry climate they inhabit as freely as they do the branches, sapping the vitality of the tree to such an extent that the fruit becomes small and valueless. If allowed to go on unchecked the trees gradually die. To the apple tree the woolly aphis is what the phylloxera is to the grapevine, sucking and causing swellings and knobs all over the roots, as well as at the root crown.

A pest as serious as this has naturally been long fought, and many are the remedies suggested for its extermination. When young trees first become infested, and it is discovered in time, a number of remedies may be effectively used.

Rubbing or brushing kerosene on the infested spots, or washing them with lye, three quarters of a pound to the gallon, or with strong solution of whale-oil soap, or sulphocarbonate of potassium, may effectually arrest the disease. When, however, the roots of a large tree once become thoroughly infested (and in this State, unfortunately that requires but little time), almost all the remedies usually recommended prove wholly insufficient, and on a large scale impracticable. For a number of years we have tried at the experimental grounds of the University, various remedies, including tobacco decoction, hot water, common lime, ashes, bi-sulphide of carbon, and several proposed remedies of unknown composition, furnished by outside parties. Of the latter that of Mr. Lille, of San Francisco, appears, so far, quite promising. We must, however, reserve our judgment for some time yet.

Gas Lime.

On a whole, we have found no remedy as inexpensive and efficacious as gas lime—the refuse of gas works. Outside of its penetrating odor this material has but one objection: it is a strong medicine that must be used with care, and the dose must be regulated somewhat according to the soil and subsoil, and the age of the trees. There is necessarily some difference in its strength, according to its freshness, as it gradually loses some of its ingredients by exposure to the air, and especially to rain. Nevertheless, when applied to a given spot, it will retain its efficacy for at least three years. Our first experiments with it began four years ago, and at the convention held in San Francisco that year I made my first statement in regard to this remedy. I stated that a marked effect had been produced by it, and that the aphis had been killed, but that in spite of the very strong dose applied to each tree (something like ten pounds), the insects were again descending to the roots. I stated, also, that some of the trees on shallow soil had been killed by the gas lime, and that on the whole the remedy was not satisfactory. During the succeeding spring and summer, however, I gained fresh confidence in it, as, with the exception of very weak trees or of those in shallow soil, comparatively few died; those less injured showed returning vigor. The gas lime had also been very beneficial to the soil, causing the heavy, stiff loam to pulverize like ashes. The next season, after the first rain, I noticed the peculiar, strong odor of the gas lime. Examination later on in the spring, showed that the aphis was not to be found about the roots, and existed right at the surface only. It evidently had not gained any headway. Altogether, the remedy now looked so promising that it was decided to give it a trial on a larger scale, but in much smaller doses; these, if proving sufficient, to be increased the next year. The call to take charge of the collection of plants for the New Orleans Exposition prevented me from carrying out my intentions at the time, and it was not until the past season (1885–6) that experiments properly guarded could be made.

The bad effect of the first application was to corrode the bark on the younger trees,

causing it to decay. Instead of removing the soil and putting the gas lime in close contact with the tree, as was done the first time, there was spread about a shovelful and a half, *i. e.*, about two or three pounds in a dry state, within a radius of four feet over the surface around the tree, trusting to the rain to wash it into the soil. To prevent the aphis from remaining close on the root crown, fresh ashes, a few shovelfuls to each tree, were piled close about the trunk. The work was done early in October, and the copious rains of this season gave good opportunity for action.

On the trees examined thus far, the result has been very satisfactory. They show, by the knots and swellings on the roots, that they were once badly infested; still, there is no aphis on them now, while on a few other trees left without treatment the insects are crowded. Two rows of trees treated several years ago, and now treated again, but having had no ashes placed about them, show the aphis working downward again. To make the work complete, therefore, it seems necessary to use ashes or some similar material close about the root.

The dose of gas lime to be given to a tree should vary according to its size and age, and the nature of the soil. In a porous, deep soil there is less danger of injury than in a clayey one, where the water charged with the antidote permeates the soil very slowly, and has time to corrode the bark. In the case of some old trees in the Santa Cruz Mountains treated last season, according to our suggestion, although the gas lime had been put right on the roots after the soil had been taken away, the roots were perfectly sound and all the aphis killed. The soil was a sandy loam, underlaid by limy sandstone. Thus, the exact dose to be recommended is a little difficult to determine. It is always safe to use a small dose first—from one shovelful on a small tree, to four on a very large one, spread over the surface, according to the spread of the root, will generally be found right.

It should be stated that a thorough treatment of the top was never made, because we wanted to see how far we could depend upon the ladybug for extermination there. From observations during the last few years, I believe that in this locality this useful little beetle can be depended upon for keeping the crown of the tree free from aphis. We cannot recommend too highly the protection of the ladybugs, *Coccinellæ*. During more than one year we have seen them completely annihilate the aphis above ground in a very few days. It is generally stated that their larvæ are the most destructive to the latter. We ourselves have witnessed what an enormous quantity of aphis the fully developed ladybug will consume. As the *Coccinellæ* hibernate on the evergreen trees, I very strongly recommend the planting of these trees (conifers, especially) around the orchard, to give the necessary shelter. I have often seen them congregated on the Monterey Cypress in such quantities that they could be taken up by the handful. Should the ladybugs not appear in numbers sufficient to exterminate the aphis, it may be necessary to kill the latter by means of washes. As it is impossible to accomplish this with one spraying on badly infested trees, I recommend two or three sprayings. This should be done in the following manner: For the first application use hot water of 140° F. in the tank, sprayed with great force. This will wash off the greater number of the insects. For the second application take tobacco water and whale-oil soap in the following proportions: In a decoction of tobacco (one gallon water to one half pound tobacco) put half a pound of whale-oil soap. Apply this mixture at about 130° F.; in about a week give another similar application. If early varieties of apples are in question, leave out the whale-oil soap, as, especially in a cool climate, the odor of the whale oil will not leave the fruit.

Resistant Stock.

There is a vast difference in the many varieties of apples as regards their resistance to the woolly aphis. The late John Llewelling, of Napa, claims to have found by experience that seedlings of Golden Russet and Rawle's Janet are exempt. We have no personal experience in the matter, but for several years, at the experimental grounds of the University, we have had growing two apple trees of an unnamed variety, propagated and donated by John Rock, of San José. Although purposely and repeatedly infected with the woolly aphis, these insects never remained either on the top or on the roots. The latter are tough and wiry, and perhaps for this reason resist the aphis, much as the wiry grape roots resist the phylloxera. The only manner in which this resistant variety can now be propagated is by grafting. Although healthy, these trees have been of rather slow growth. Doubtless there are, among the many varieties of apples, others equally resistant, and it would be well to pay close attention to this point.

W. G. KLEE.

Berkeley, May 6, 1886.

THE PLUM APHIS AND ITS FOES.

The work of beneficial insects in reducing the aphis has been quite fully alluded to in previous reports. This year there was unusual extension of the aphis on plum and other orchard trees, also on garden plants. It was gratifying, however, to discover in most of the specimens of infested leaves which were sent the eggs of the syrphus fly or the lace winged (*chrysofa*), and the request was made of those sending specimens, that they would watch the work of these aphis-eaters. The general result was that a num-

ber of reports were sent, like that of Mr. George Johnson, of Vina, Tehama County, who wrote under date of June 27, 1886, as follows:

As you predicted, the syrphus flies and ladybirds, of which there were great numbers, completely cleaned the trees of the aphis; not a single one can now be found. Before your letter had arrived the gardener had sprayed the melons, which were also infested with aphis, with a weak decoction of tobacco, which destroyed the insect completely.

The aphis appeared upon the University plum orchard in large numbers early in the season, and the trees were sprayed with a weak solution of whale-oil soap, which killed many of them. There was, however, a rapid multiplication of those left by the spray, and some of the trees were again fully infested with the aphis. As the eggs of syrphus flies also appeared in promising numbers, it was decided to give a new test to the efficacy of the beneficial insects, to see if it would verify the record of their value made in our earlier reports. As the aphis pest was reported from so many localities, notes of the progress of the experiment on the University grounds were published in the Pacific Rural Press of June 12, 19, and 26, 1886, that others might be induced to make similar observations. The following is a condensed record of the notes to which allusion is made:

The little plum orchard at the University was attacked by the plum aphis a few weeks ago, and was sprayed with a mild solution of whale-oil soap, which killed millions, as their blackened remains on the under surface of the leaves bore witness. There were, however, enough survivors of the spraying to multiply and reinfest some of the trees, the Yellow Gage being most afflicted. A good many of the leaves were so covered on the under sides that there was hardly standing room for the aphides. The trees would have been resprayed were it not that many eggs and newly hatched larvæ of the syrphus flies were to be seen among the clusters of aphis. For the purpose of observation, and to see how badly a tree could be infested, and yet the foliage be rescued by the natural enemies of the aphis, it was determined to stand aside and trust to the "balance of nature," which the naturalists tell us will be preserved by natural agencies.

The aphis seemed to have much its own way during the early days of the experiment; it was evidently multiplying faster than the light green worms, with their prehensile front segments, could make away with them. It began to look as though the tree would lose many of its leaves, and as some of the younger twigs were completely encircled by masses of the aphis, it looked as though something more than the leaves might have to go. Still there were quite a number of syrphus flies hovering about, and ladybirds running about over the branches, and we were not sure that the fattening plant lice would always have so flourishing a time. Such was the condition of affairs on Monday morning of this week (June seventh).

When we went out early on Tuesday morning the whole aspect of the affair had changed. The trees were swarming with syrphus flies, some with yellow bands on their abdomens and some with white, swarming like yellow jackets over a tray of sliced fruit, buzzing about and from time to time alighting to drop a very small, whitish, oblong-oval egg among the aphides. Casual observers might take them for yellow jackets, but look closer and you will see that they have but two wings and are generally like the house fly rather than the wasp. With the syrphus flies there were also hosts of house flies and others of their family, evidenly attracted by the honey dew, and bearing no more relation to the contest we were watching than camp followers do to the prowess of an army.

But, though these syrphus flies were so abundant, they can only furnish fighting material when it has time to grow up. They may like to lap honey dew, but they have no mouth for aphis killing. They only plan to plant their eggs so that the forthcoming larvæ may have a feast. There were, however, active forces at immediate work. They were the ladybirds. The day before there were but few to be seen. On Tuesday morning there were millions. The foliage, twigs, branches, and trunks were almost red with them. They covered the ground. They could be seen on the highest leaves. They had evidently scented the battle from afar, and had come from the whole neighborhood to seek a full diet on these aphis-ridden trees. There were several species of them—pale yellow and red, unspotted, and with spots in variety. Along the twigs and leaf stems they tumbled over each other in their rushing hither and thither. On the aphis-covered leaves they were scattered like a lot of schoolboys in a strawberry field. We saw as many as ten vigorously stuffing themselves on single leaves. They were working havoc with the aphides most assuredly, and they promised to hold them in check for a few days until the syrphus larvæ appear upon the scene. But they, too, were preparing reinforcements of their own. Here and there upon the bark of the trees could be seen the clusters of their yellow eggs, and soon their hungry larvæ will be released to rival the syrphus grubs in aphis eating. Here and there also we found the pearly egg of the chrysopa, or lace-winged fly, upon its slender pedicel, and a few *podabrus* beetles, long, slender, and shy,

with their saffron bodies and chocolate wing covers, evidently displeased that the field was so crowded with the bustling *coccinellæ*.

Thus the battle stood when we visited the tree on Wednesday morning. It was teeming with insect life. A few more lace-winged flies were floating about, and the other allied hosts had accessions also. Probably by next week we can give the result of the battle.

The massacre of the aphides by the allied forces of ladybirds, syrphus larvæ, etc., which we mentioned last week as in progress in the State University orchard, has continued vigorously, and will not stop until the last aphis is wiped out of existence. We have watched the trees from day to day. On the two trees of yellow gage, where the contest between appetite and fecundity began, there has been a steady diminution of the aphis. We have seen as many as twelve ladybirds at work on the underside of a single leaf. They make clean work, either moving abreast across the leaf or being arranged around the outer edge, and eating toward the center. They do not run about and pick up here and there, but go forward slowly, the mass of aphis before them, the clean surface of the leaf behind. They spare neither sex nor age, but advance, relentless as fate.

The aggregate force of ladybirds in the orchard has greatly increased by accessions on the wing since last week. The eaters are still the perfect insects (ladybirds), and we can fully approve the remark made by Mr. Klee in his recent University bulletin (No. 55) on the woolly aphis concerning the appetite of the perfect insect being generally underestimated. Most of the plum trees have now become covered with them, searching high and low for aphis colonies. Other explorers went into crabapple trees adjoining, and found, in two trees of transcendent crab, colonies of woolly aphis looking almost like patches of cotton. Along some of this year's wood the cotton was massed at the base of every leaf stem, and the trees were a sorry sight. Within four days after the ladybirds took a good hold on the woolly aphis there was not a vestige of them remaining, except here and there on the leaves where individuals had escaped the jaws of the beetles and fallen from the clusters. There is no doubt that enough ladybirds will make perfect work on the woolly aphis on the branches.

The destruction of plum and woolly aphis on the University orchard trees, to which we have alluded in the last two issues, has been accomplished by the ladybird without aid from their larvæ or from other aphis-eating insects. Excepting a few which linger, running over the leaves and branches in search for a stray aphis, the ladybird army has folded its tents and departed. We find very few eggs deposited in the immediate vicinity. The crabapple trees which were so badly infested with woolly aphis on the twigs and branches are now clean, and a rear guard of the destroyers is skirmishing around the battleground. This year's observation affirms that made before at the University, that ladybirds are able to reduce quite a grievous visitation of aphis, so far as the tree is concerned. The woolly aphis is, of course, expected to renew itself from the infested roots, unless the gas-lime treatment, described recently by Mr. Klee, should make way with the subterranean forces.

THE CHILOCORUS BIVULNERUS.

This member of the *Coccinellidæ*, or the ladybird family, is of shining black color with an irregular reddish spot on each wing cover. It might be called, in popular phrase, the "red-spotted black ladybird." Its beneficial work in reducing scale insects in this State is quite fully described by Mr. Klee in Bulletin No. 3 of the State Board of Horticultural Commissioners, published August, 1886. This insect has been brought into Southern California from Florida because of its scale-eating proclivities, and also sent from place to place in this State, where it is said to have multiplied and done good work. It and its congener, *Chilocorus cacti*, which was noticed in this State in 1880, by Professor Comstock, are also found here so widely distributed as to indicate them indigenous or long introduced. At San José (as described by Mr. Klee) the *Chilocorus* is rendering effective service to the fruit growers. We collected specimens of the insect in Berkeley in 1885. As indicating how widely the *Chilocorus* is distributed on this coast, we would mention the fact that we received a specimen of the larvæ from Samuel Haigh, Coquitlam, near New Westminster, British Columbia, in September, 1885. Mr. Haigh writes: "I have discovered an enemy to the apple scale, which is rapidly cleaning out this pest. It lives chiefly upon the young as they emerge from the parent shell in June, in this latitude."

Professor Comstock reports finding this insect feeding upon the black scale upon the oleander. We found it doing the same work on the orange. At San José it has proved deadly to the *Aspidiotus perniciosus*, or San José scale.

GOOSEBERRY PESTS.

Insects, different from the old pests of the gooseberry, the midge (*Cecidomyia grossulariæ*) and the "gooseberry worm" (*Pempelia grossulariæ*), have made themselves obnoxious to gooseberry growers, in some localities at least, on this coast. One is reported by N. Wagenseller, of Ukiah, and is described by him in these words, which are taken from his letters on the dates given:

March 17, 1886.—My gooseberries, for the last two years, have been troubled with something that makes a hole in them when they are the size of a grain of wheat to that of a pea. More than half my crop has been destroyed. From some bushes all fell off, while other bushes lost but few. Most that remain on the bush after they get the size of a small pea, are not troubled afterward, but grow to marketable size and are all sound. Those which are not picked to sell green, ripen all right and are perfectly sound.

April 19, 1886.—To-day is the first day I could make a thorough examination of my bushes, because of the continued rains. I find but few berries affected. I am sure now, however, that the worm is not hatched in the berry, but eats its way in from the outside. * * * Since writing the above I have made another examination, and find worms of various sizes. They are not visible, but fall upon shaking the bush. The leaves are not eaten.

April 20, 1886.—To-day I found one of the worms going into the berry, head first.

The worms sent by Mr. Wagenseller were smooth, lepidopterous larvæ of a greenish color and dark stripes. Those most advanced were fully an inch in length. They were put in a rearing cage suitable for such larvæ, but died before undertaking transformation. As I did not recognize the larvæ and failed to secure the moth, it has not been possible to determine the insect. The insect will be studied more fully at the next fruiting time of the bushes.

Another case which was quite as unsatisfactory is that of a pest affecting gooseberries in Oregon, and is described by Dr. F. S. Matteson of Aumsville, Marion County, Oregon, in his letter of June eleventh, as follows:

I send you by this mail a box containing a few gooseberries injured by some insect. This insect does not appear to be the regular gooseberry stinger of former years, which has not troubled us this summer at all. The one now sent appears to be a new style of operator, and does not cause the berries to drop off prematurely like the other. He has done but little damage this season. The little round hole in some of the berries sent is, I think, eaten into them by a green worm which stays on the bushes.

These specimens were duly received. The punctured berries were evidently injured by an outside-feeding worm of which no specimens were found. They, with the others, were carefully placed under a bell-glass, but gradually dried up, yielding nothing which could be taken for a depredator. These cases are reported merely for the purpose of making the injuries known to gooseberry growers generally, in the hope that others may be also led to watch for the pests and study their habits.

CICADA EGGS.

Samples were received June 7, 1886, from Mrs. C. E. Kinney, of a *cicada* (so far as I know, undetermined), which has done considerable injury this year by ovipositing in the small branches of fruit trees. This pest has been complained of for many years in the foothills. Mrs. Kinney writes:

This pest made its appearance last year, in a limited way, but is present in such numbers this year as to seriously affect our large and hitherto promising orchard. The young apple trees seem to suffer the most, but pears, and, in fact, most every variety of tree, shows traces of its work. It pricks the upper side of limbs of last year's growth, depositing its eggs, after which the twig soon dries up and dies. What can be done for this pest?

The only remedies which seem available are the careful search for the infested twigs, which can be easily seen, on small trees at least, by their torn-up bark where the fly has chiseled in to deposit her eggs, which are set in rows in the fiber and pith of the twig. Gathering and burning these will reduce the following year's crop of the fly. The other treatment is to apply some offensive wash to the tree at the time the flies are ovipositing. A whale-oil soap wash is probably the most available. The proper time for application must be learned by watching for the appearance of the flies.

WASHES FOR SCALE INSECTS.

In view of the many questions received as to the comparative strength of the various whale-oil soaps and alkalis offered for sale, and requests for advice concerning the preparation of washes, and to serve as a guide in our own operations as well, an examination of insecticides was undertaken. The results of this, and practical suggestions drawn from them, were promptly published in bulletins. University Experiment Station Bulletin No. 52 was issued February 6, 1886, as follows:

ALKALINE WASHES FOR FRUIT TREES.

In response to numerous inquiries regarding the relative strength and merits of the several materials for alkaline tree washes now offered in the market, I give below the results of the analysis of five of the most prominent, lately made at the agricultural laboratory of the University. No. 6 gives the usual composition of Canadian crude potashes, as found in commerce, and may be taken as representing that of the lye of wood ashes when boiled down. It is the material from which No. 5, the "commercial caustic potash," is made by treatment of lime.

Composition of Commercial Alkalis.

1—"Philadelphia solid lye," sent by R. Wheeler, Fresno.
2—American concentrated lye, from San Francisco agencies.
3—Double concentrated 98 per cent caustic soda, from Greenbank Alkali Works Company, St. Helena, Lancashire, England; T. W. Jackson, agent in San Francisco.
4—Refined pearlashes, same manufacturer.
5—Commercial potash, Langley & Michaels, San Francisco.
6—Canadian crude potash, commercial.
7—Eureka lye, M. Ehrman & Co., manufacturers, San Francisco.

	1.	2.	3.	4.	5.	6.	7.
Caustic soda	22.7	80.4	99.3	------	------	------	91.0
Caustic potash	------	------	------	------	52.3	------	------
Carbonate of potash	------	------	------	69.1	16.8	71.4	------
Chloride of potassium	------	------	------	------	------	3.6	------
Chloride of sodium	66.6	5.9	------	------	4.9	------	5.6
Carbonate of soda	------	------	------	------	------	2.3	------
Sulphate of soda	------	13.2	------	------	14.8	------	4.2
Sulphate of potash	------	------	------	------	7.5	14.4	------
Silica	------	------	------	------	.1	------	------
Insoluble residue	------	------	------	------	2.1	2.7	------
Moisture	6.4	.5	------	23.8	1.5	4.5	------

The three first numbers represent, or should represent, the basis of the lye washes for fruit trees, the active part being the "caustic soda" or sodic hydrate, preferred to the corresponding potash compound simply because it is cheaper. The purchaser should understand that this caustic soda is all that he wants to pay for when tree-washing is his object. The rest, even though soluble in water, are to be considered as impurities of little or no practical value to him. From this point of view the "Philadelphia solid lye" should be let severely alone, two thirds of it being common salt, which any one can put in for himself if so inclined. For tree-washing, however, salt is no manner of consequence, and is often in the way of other materials that may advantageously be combined with the lye in some cases, *e. g.*, soap.

The "American concentrated lye" is a *bona fide* preparation, resulting from the treat-

ment of commercial soda ash with lime. We have found it to range as high as ninety per cent of caustic soda, and eighty is probably as low as it goes.

The English "double concentrated ninety-eight per cent caustic soda," from the Greenbank works, is an unusually pure product, exceeding, as the analysis shows, even what is claimed in its name for its percentage of effective caustic.

A glance at the "caustic soda" percentages will show good reason why some persons, when using "one pound per gallon" of water, fail to kill the scale, while others not only kill the scale, but severely scorch the trees. It would take just *five* pounds of "Philadelphia solid" to be equal in effect to *one* pound of the Greenbank "double concentrated," or to one and a quarter of the "American concentrated."

Again, if a wash containing a pound of the latter to a gallon of water is used warm, it will kill the scale and may leave the tree unharmed, while a similar proportion of the "double concentrated" would scorch the tree if used hot, but might leave it unscathed when applied cold. A pound of the "Philadelphia" would be harmless to anything but a young scale just hatched and moving. Hence the wide differences in the experience of different persons is readily explained on this ground alone.

But there are several other causes for these differences. One of the most common is that a strong lye, say a pound to the gallon, may be applied with impunity to trees that have never been sprayed and are full of moss and old bark, which, dissolving in the lye, weakens it materially. The same lye applied to a clean tree will in reality remain considerably stronger, and may scorch it.

Another, and incredibly common cause of difficulty, is the failure to make all the solid lye dissolve and form a uniform solution before using it. When, as is very commonly done, the drums are merely burst open with a hatchet, the lumps of soda lye cracked a little, then thrown into the boiler and water poured on them, it takes a great deal of time, boiling, stirring, and patience to make the result correspond with what the prescription intended. A dense, heavy, oily solution will form over the bottom, and with a strong fire there will be a great deal of spluttering and bumping there; but the lumps obstinately refuse to dissolve with any reasonable degree of rapidity, and when the workmen find that the water above is pretty sharp in its action on their hands, they think it will do for the scale also, and off it goes into the spray pump. When they come down to the bottom of the boiler, the lye is "double concentrated" in dead earnest. It is extra hot, too. When this last lot goes on the trees the scale goes, of course, but the bark of the tree also. On the other hand, the scale continues to flourish where the first weak part of the lye was applied, and the general outcome is as unsatisfactory as the worst grumbler could desire.

All such difficulties can be easily avoided, and a great deal of time saved, by putting the solid lye on a (tin or sheet iron) perforated shelor colander, so placed that the lye will be near the surface of the water instead of at the bottom. Then, when a lively boil is set up, there will be no spluttering. The lumps will dissolve in the shortest time that their size permits, and the result will be a solution of uniform temperature and strength throughout.

Precisely the same rule applies to the potash compounds, given in Nos. 4, 5, and 6. The chief reason for using the latter at all, notwithstanding their higher price, is, that being "deliquescent"—that is, attracting water and spontaneously forming a permanent solution, by simple exposure to the air—they serve to maintain the corrosive action for a greater length of time than would the soda lye alone, unless under exceptionally favorable conditions.

In examining trees that have been sprayed with soda lye alone on a sunny day, it will sometimes be found that within an hour after the spraying the dry portions are covered with a network of small, white needles, resembling white frost. These needles are simply solid carbonate of soda, and show that by the action of the dry air, the "causticity" of the lye has been quickly destroyed. The bland, common sal-soda has taken its place, and the action is practically at an end.

It is quite otherwise when the spraying has been done on a moist or foggy day, or late in the afternoon, so that the lye remains in a liquid condition. It then goes on working for many hours, eating away the edges of the old scale, and finally reaching to the old insect or eggs inside; and, should favorable weather continue, the toughest old inhabitant may thus be destroyed in a single application.

The use of the potash compounds in connection with the soda lye aids materially in maintaining the active corrosion more or less independently of moist weather, by preventing the rapid evaporation and solidification that so often puts a premature end to it. Moreover, the potash compounds so used ultimately reach and remain in the soil, and act as a fertilizer when needed, so that the money spent on them is not gone with the insects.

Of the three commercial potash compounds, of which the composition is given above, No. 5, the "commercial caustic potash," is the most effective. It might, of course, be used alone, but for its higher price and lower grade of caustic, which would make such use rather expensive. To secure the point desired, viz., the maintenance of the fluidity of the wash in dry weather, it is sufficient to use half as much as of the soda lye. From my personal experience I recommend one pound of the "American concentrated lye," or four fifths of a pound of Greenbank "double concentrated," and half a pound of the "commercial potash" to two gallons of water, as the strongest wash necessary to be used, and still safe, on all dormant trees. In bad cases to be used hot, so as to show 140° in the tank, when it will reach the tree at 110°, or thereabouts, varying according to the fineness

of the spray and the dryness of the air. The finer the spray and the drier the air, the more the fluid will be cooled before it reaches the tree.

Instead of the "commercial caustic potash" (No. 5 of the table), Nos. 4 or 6 may also be used, if more conveniently obtainable. In that case, however, three quarters of a pound instead of one half should be used with each pound of solid soda lye and two gallons of water.

The addition of a tablespoonful of sulphur per pound of lye during the boiling is probably useful and should be tried. When consulting economy in the use of these washes, it should be remembered that fine spray is much more economical than coarse droplets, of which a large proportion falls to the ground before a wetting of the whole tree surface can be assured. *A fine jet with heavy pressure is required for fine spray.* In the case of large trees where drops from above are caught by the lower branches, a "San José" nozzle with ordinary pressure is, perhaps, as economical as any; but for small trees, from which all that does not stick to the bark falls to the ground, the fine spray from a "Cyclone" or "Imperial" nozzle under high pressure is more economical.

Many persons cut back their trees severely, in order to induce a clean new growth, and also save expense in spraying. It should not be forgotten that the strong lye falling on the open cuts causes the stumps to die for one, and sometimes several inches below the cut, unless the latter are waxed over. As the infested brush remains for some time a source of danger from reinfection unless promptly dealt with, it is often questionable whether it is not cheaper to include it in the spraying, and prune it afterward, rather than to run that risk.

In the preparation and use of the several tree washes, there is abundant room for the exercise, not only of common sense, but even for that of uncommon acumen, if good and uniform results are to be obtained. It is not at all surprising that numerous failures should occur when the matter is left to untrained workmen alone, with such miscellaneous materials as are shown in the above table of analyses.

E. W. HILGARD.

Berkeley, February 6, 1886.

Note.—Eureka lye, M. Ehrman & Co., San Francisco.—This article was sent in after the publication of the bulletin, and it will be seen by reference to the table of analyses, that in its contents of effective caustic soda it ranks next to the high grade article of the Greenbank Alkali Works, and nearly eleven per cent above the American concentrated lye.

WHALE-OIL SOAP INSECTICIDE WASHES.

University Experimental Station Bulletin No. 56, issued May 17, 1886, was as follows:

Among the ingredients of insecticide washes intended for summer use, or on evergreen trees, whale-oil soap is one of those most commonly employed, as well as most generally approved, in California. It is quite effective in numerous cases even when used by itself, but it is most commonly combined with, or made the vehicle for, other insecticide substances. Instead, common soap is also employed, but its chief merit lies in the fact that it, in common with other soapy compounds, serves to conserve the efficacy and maintain the action of other insecticides for which it serves as a vehicle. This it does partly by virtue of its property of promptly wetting even hairy, greasy, or polished surfaces (whether of leaves or insects), from which simple water would rebound or gather in ineffective droplets, partly because it remains more or less moist, and in that condition forms a soft, clinging varnish, under which the action even of volatile agents (such as kerosene or the extract or powder of "buhach") can continue for some time without too much wasting of their strength into the surrounding air by evaporation.

But whale-oil soap possesses the additional advantage of having, within itself, special odorous substances of insecticide qualities which impart to crude whale oil its intensely disagreeable odor. From these it is partly freed, in the refining process, by the action of a certain proportion of caustic alkali (mostly soda), which takes possession *preferably* of the odorous compounds of the crude oil, together with a certain proportion of the inodorous fat oil. This soapy mixture constitutes the "foots" of the refineries, and is far more energetic in its insecticide effect than soap made from the *whole* of the crude oil, which contains a relatively much smaller proportion of the evil-smelling substances.

This fact alone explains much of the diversity of opinion that has arisen in the matter of proportioning the strength of the soap washes to the desired effect. For not only has the soap made from the *whole* oil been supplied by some manufacturers, but those using the washes have, in many instances, made the soap themselves in accordance with the common process of making soft soap at home.

Matthew Cooke, in his excellent book on the repression of injurious insects, prescribes that one pound of the soap dissolved in one gallon of water shall constitute the basis of the washes. Some have found this wash unnecessarily strong, while others have found it too weak to accomplish anything.

In a bulletin issued in February last (No. 52) were given the analyses of sundry brands of "lye," from which it appeared that they differ in strength as much as five hundred per cent; so that a person using the proportions prescribed for one kind would, in using the

other, make his wash too strong or too weak, as the case might be, to that precise extent, either wasting his work or perhaps scorching his trees.

An examination of the several brands of whale-oil soaps in the San Francisco market has revealed similar differences between them. In this case the inert substance present to excess in some samples is simply water, which was found to range, in different preparations *sold at the same price*, from 21 to as much as 82½ per cent. Curiously enough, the most highly watered article was among the most salable; the reason being, probably, that while the article having nearly 80 per cent of soap and 20 of water is somewhat difficult to dissolve and has to be boiled, the one in which these proportions are reversed can be made into a wash by simply stirring it into cold water. But apart from this inconvenience, the one is actually and indisputably worth fully four times as much as the other for the purpose it is intended to subserve, provided that the user will take the trouble to put in the water himself, instead of having it shipped to him from San Francisco.

It is no wonder that the experience of fruit growers differs widely as to the efficacy of whale-oil soap in ridding their trees of insect pests.

From a comparative examination of the samples on hand, it appears that a whale-oil soap containing about 50 per cent of water is as readily dissolved as any moderately energetic fruit grower need desire; and, in view of the relatively small weights of invoices usually shipped of this article, I suggest that it would be convenient to users if all manufacturers would adopt the standard of 50 per cent of dry soap to be contained in whale-oil soap as offered for sale. There will then be some definite meaning to the prescription of "a pound to the gallon," and disappointments after the proper use of washes prepared according to the best experience will cease to occur.

E. W. HILGARD.

Berkeley, May 17, 1886.

Note.—More recent chemical analyses of insecticides and formulas for their preparation may be found in Appendix I of this report.

AN ENEMY OF THE OAKS.

The evergreen oaks (*Quercus agrifolia*) on the University grounds have been twice defoliated during the summer of 1886 by the larvæ of the *Phryganidea Californica*, which appeared in vast numbers about the first of May. The moths were very abundant in June, again in August, and again during the latter half of October. They were observed pairing freely on October 24, 1886, but of a large number caught on the wing there was a great preponderance of males in October, while in June most catches were females. The moths were numerous until a cold rainstorm early in December. The first brood of the season appeared to be the most abundant. This insect, as shown by inquiries received concerning it, was quite prevalent this year among the oaks, in the bay region at least. Special complaint came from the Napa Valley, where the trees were represented as infested in nearly all parts of that region. Specimens have also been sent from the Santa Cruz Mountains. No treatment was attempted because of the size of the trees, and because the insect being native, and the trees having periodically to suffer from it, were not in danger of permanent injury. Probably it will disappear as suddenly as it multiplied, when its natural foes catch up with it. The worm is rather slender, black above and greenish below, striped, and about one inch long when full grown. It may be recognized by its immense, globular, pale brown head, which is so large in proportion to the diameter of the body as to seem almost a deformity. A full description of the insect may be found in Bulletin No. 7 of the United States Entomological Commission, by Professor A. S. Packard, Jr., entitled "Insects Injurious to Forest and Shade Trees." The moth is of a dull brown color, wings semi-hyaline, and about an inch and a quarter across its outspread wings.

APPENDIX V.

REPORT ON DISTRIBUTION OF SEEDS, PLANTS, AND SCIONS, AND DONATIONS RECEIVED.

By E. J. Wickson, Lecturer on Practical Agriculture, and Assistant Superintendent of Agricultural Grounds.

Professor E. W. Hilgard:

Sir: I herewith submit an outline of the work done in distribution of seeds, plants, and scions during the last two years, and donations received during the same period.

E. J. WICKSON.

GENERAL REMARKS.

This branch of the experimental work of the College of Agriculture has reached large dimensions. The interest of the agriculturists in different parts of the State to try the plants which are found in our local experiments to be promising, has brought the institution into direct communication with careful experimenters and observers in all the counties, and thus enables us to determine the value of new plants; not only in the soils and conditions of Berkeley, but, practically, in all the various soils and climates of the State. Thus we are able to meet the very forcible objection which has sometimes been brought forward, that experiments in the vicinity of San Francisco Bay only represented adaptations of a comparatively small area of the State. We have now several hundred colaborers testing new plants, and reporting their observations and results to us, and constituting a very effective system of outlying stations for experimental work. The results of this system may be found in various parts of this report, in the notes given in answer to our requests. Such voluntary work does not, of course, in all respects answer the demand for accurate, skilled observation, but it serves an excellent purpose in broadening the work of the college, and may serve at length as a foundation upon which may be established a system of well located tributary stations, equipped to undertake the special work which seems locally demanded.

REPORTS REQUESTED.

At the date specified, the following circular was sent to those who had received seeds and plants previous to the distribution of 1885–6:

University of California, College of Agriculture,
Berkeley, October 10, 1885.

Dear Sir: It is desired to publish a report giving local experience with the plants and seeds sent out from the University Experiment Station. Will you kindly write at once,

giving your experience with those sent you, and all information concerning them which would be of value to other experimenters.

Please address— E. W. HILGARD,
Berkeley, Cal.

In answer to this request nearly four hundred reports were received. Facts of general interest from these, will be found embodied in the statements concerning different plants, in other parts of this report.

ANNOUNCEMENTS OF DISTRIBUTION, 1885-6.

(*Bulletin No. 47—Seeds.*)

The character of the season just passed prevented a fair test of the seeds sent out last year. As some of the varieties distributed last year have shown such excellent qualities on the University experiment grounds, and in the hands of a number of our correspondents, we have decided to offer many of them again this year, hoping that a more liberal rainfall will give all an opportunity to determine their value in the different regions. We have also added to the list several new growths which promise well. As has been stated in previous announcements, this distribution is made for the purpose of ascertaining the adaptation and practical value of the several kinds in the different climates and soils of the State; and persons receiving them are requested to report results, whether success or failure, and if the latter, from what apparent causes.

As there is no appropriation available to meet the expenses of packing and postage, applicants for the seeds are requested to send the amounts specified in connection with each description below. If they desire seeds sent by express, applicants need not send money with their orders. Applications may be made for one or more kinds of seeds. In case any kind of seed becomes exhausted, the money sent will be returned unless a second choice is mentioned by the sender. Amounts less than $1 may be sent in postage stamps if convenient; larger sums should be by postal note, *payable at the Berkeley Post Office.* A distribution of plants and scions will be announced hereafter.

Barley.

The following barleys and wheats will be forwarded by mail to applicants who send 20 cents for one-pound sacks and 36 cents for two-pound sacks:

Six-rowed Barley: A very different type from that commonly grown on this coast, and we believe that for some localities and uses it is much to be preferred. The arrangement of the grains in the head is such as to show six distinct rows, instead of the crowded appearance which makes our common barley pass as four-rowed. The straw is of only moderate length, strong and very erect, making it less liable to lodge than most other varieties. The heavy rains of June, 1884, which prostrated nearly all the other grains on our grounds, did not affect this variety. It stood erect and strong. The yield is among the highest that we have recorded in our experiments. Our stock was raised from seed secured in the Brenner collection, imported from Europe, where the grain is also particularly valued for mountain lands. We commend this grain for a general trial, and in particular for the northern valleys of the State.

Rice, Sprat, or Battledore Barley: In some respects there is a close resemblance between this variety and the last, as in its upright straw, heads of even height and spreading beards. Straw very short, and, like the six-rowed, did not lodge. It has two rows of grain in a very short head, so that the beards stand in the form of a battledore. The grain is said to swell when cooked, as rice does. The yield is fair, and the hardy plant adapted to mountain regions—an interesting variety.

Scotch Two-rowed Barley: In a series of years this has proved to be a very superior grain, both in yield and quality, as well as in not lodging as badly as Chevalier. We have good reports from seed sent out in former years.

Imperial Two-rowed: Good, but not as well proved as some others.

Wheats.

Whittington Wheat: A favorite in England, and promising well here, when sown early, though on our soil becoming more starchy than the original seed imported by the University. Seed, long and resembling the white Australian; should be tried on various soils. The Whittington grown on the University grounds has been pronounced a good flouring wheat by a competent miller. It is the best yielding wheat we have grown.

Black-bearded Centennial: From seed received some years ago from the United States Department of Agriculture. A variety that has been widely disseminated and much praised. Its very tall and strong straw, large heads, and long beard, which is black during growth, make a very showy crop. The beards are shed when the grain matures. It has been especially commended by California millers. The yield is good.

California Spring Wheat: Received from Germany under this name, but not yet identified with any variety generally known here. It seems adapted to our climate. Head of medium length, compact, beardless, with white chaff. The grain looks well, is round, rather small, soft, starchy, and fairly even in size.

White Silesian Spelt-Wheat: In the chaff. This type of wheat is prized in Europe for pastry, although the chaff must be removed by a process similar to that employed with rice, and therefore is less desirable than wheat for a bread grain. With us it has never made really a plump grain, perhaps because of late planting, as it apparently needs a longer growing season, as regards moisture or mountain climate; its preferred location in Europe. Our own experience, and that of others, indicates that its hardiness and leafy growth would make it valuable as a hay crop in the mountain regions of the State. It is sown in the chaff. Spelts succeed on a poorer and rougher land, and are hardier than wheat. The grain cannot be plucked by birds. We have but a moderate supply, and can send in one pound sacks, twenty cents each.

Rye.

St. John's Day Rye: Heavy drooping heads; broad near the stem and tapering toward the tip. Abundant fine beards. Acknowledged to be one of the best of known ryes; from seed imported from Erfurt, Germany. For one-pound sacks, send 20 cents.

Swedish Sand Rye: Another good variety imported from the same place and recommended for sandy soils. We would like to have this variety tried on light soils for dairy feed as well as grain. For one-pound sacks send 20 cents.

Forage Plants.

Seeds of the three following grasses will be sent in four-ounce packages; send 5 cents in stamps for each:

Schrader's Brome grass (*Bromus Schraderii* or *unioloides*): Valued in Australia as resisting drought, and in Texas as giving good feed in winter and early spring. We have received reports from those in this State to whom we sent seeds two years ago, declaring the grass a success. It is among the first grasses to start, grows vigorously, and matures an abundance of heavy seeds almost like oats. Its seed stems being two or three feet high, and leafy, it can be used for either hay or pasture.

Hungarian Brome grass (*Bromus inermis*): From seed imported by the University from Europe, commended by the French, as adapted to dry soils. Our experience indicates that it will do well here, either without or with moderate irrigation.

Milium multiflorum: A perennial millet grass, growing about two feet high with seed stems two feet higher. It is a plant of slow development, but strong. Owing to the fineness of the seed, it should be planted very carefully and covered lightly. It should not be pastured the first year, as it is easily pulled up by the roots. After being well established, if grazed down, there is an abundant growth of fine leaves, which resist winter frosts to a remarkable degree. We have had favorable reports from the plants from different parts of the State, although some experimenters have complained of its failure. This is perhaps owing to the fact that it is hard to start, and because the season was unfavorable.

Black Medic or yellow trefoil (*Medicago lupulina*): A clover-like plant of very dense growth, very much like burr clover. It has grown on our experimental grounds without water; reseeds itself freely; adapted to moist, rich, clayey soils, where it will make a fine pasture. It can be sown like alfalfa. For two-ounce package send 2 cents.

Snail Clover (*Medicago turbinata*), from southwestern Spain: An annual, closely related to burr clover, but the spirally twisted pod is free from spines, and will not cling to the fleece of sheep. It starts with the first heavy rains, and makes a dense, low mat of foliage. At maturity the ground becomes thickly covered with nutritious globular pods. For two-ounce package send 2 cents.

Tagasaste (*Cytisus proliferus albus*): A species of broom; a bush-like plant, recommended by the American Consul at the Azores Islands as a valuable forage plant for dry hill lands. We have very little seed, and it will be sent to those who desire to make a careful test of the plant. To facilitate germination hot water should be poured upon the seed and allowed to stand for twelve hours before planting.

Evergreen Millet: This is the popular name for *Sorghum halepense*. It is an unfortunate name, because the plant is not evergreen, nor is it a millet. We have received conflicting reports concerning the value of this plant. It must be understood that it will not flourish on a poor, shallow soil, nor excessively heavy or stony soils, nor will it generally do much the first year. It is always late in starting in the spring, and is cut down by the first severe frost. In favorable situations it makes a very heavy growth during the summer. It should not be planted where it is not desired to remain, as it is hard to eradicate, and will spread to adjoining orchards or vineyards, especially in light, moist soil. Pound packages of root stocks, 20 cents each. For planting, cut the roots two eyes to a piece, plow a light furrow, and cover in.

Black Wattle.

Acacia decurrens, the black wattle or tanbark acacia of Australia: The bark of this tree, as grown on the University grounds, contains, as heretofore stated (Bulletin No. 4), over 40 per cent of tannin when in the air-dried condition, while that of the oaks usually amounts to only 10 or 12. The tree is a rapid grower, and is usually stripped in its eighth to tenth year, when thirty to forty feet high. Does well on heavy as well as on light soils, provided they are deep; is doubtless hardy from Sacramento southward; possibly farther north on light soils. The seed is very hard and should be soaked well in warm water until softened, before sowing, otherwise it may be in the ground a year before com-

ing up. As the wattles do not bear transplanting, the seed should be sown in pots or boxes, and removed to open ground with a ball of earth attached when quite small, say six or eight inches in height. The trees may be successfully started in open ground, by planting the seed in hills about ten feet apart, covering it not more than half an inch deep with well pulverized soil. When the plant grows, all but two or three of the most vigorous ones in each hill can be removed. For further information see Report of College of Agriculture for 1882; subject, "Tanning Plants." The seed will be sent in two-ounce packages for 4 cents. A few parties in suitable localities may be supplied with larger quantities for tests on a larger scale.

Insect Powder Plants.

Pyrethrum cinerariæfolium and *P. roseum*, the Dalmatian and Persian insect powder plants; The former is the one most to be recommended as an insecticide, while the latter is quite ornamental, having flowers resembling single chrysanthemums, of four or five different colors. The seed should be sown in boxes in light, porous soil, and kept shaded, but in a warm place and moist. Under favorable circumstances the seed will germinate in two or three weeks, and the plants, when of sufficient size to be handled, should be set out like cabbage plants. We can furnish the seed in one-ounce packages, 2 cents. For a full discussion of these plants see report of the College of Agriculture for 1882. All applications should be addressed to

E. W. HILGARD.

Berkeley, California.

(*Bulletin No. 50—Plants and Scions.*)

The following kinds of plants and scions of proven or probable economic value in this State will be available for distribution from the University during the present season. Plants will not, as a rule, be ready for sending out until on or about February first, while scions may, if desired, be sent as pruning progresses. Applications should be made at once, and will be filled in the order in which they have been received, omitting, however, such plants as are known to be unadapted to the climate of the locality concerned. Since, moreover, the object of the distribution is to test the adaption of the plants in as many localities as possible, numerous applications from one and the same locality cannot be filled unless a surplus remains after those from different sections have been supplied.

Plants will be forwarded by express, scions by mail (unless specially otherwise requested), in lots consisting of the number hereinafter mentioned for each kind, on remittance of 25 cents for each lot of plants, and 10 cents additional for each additional lot to pay expenses of packing, etc. For scions send 10 cents for each dozen ordered. Postal notes, payable at the Berkeley Post Office, are requested to be sent in lieu of stamps whenever practicable. Any surplus left after filling orders as far as possible will be returned to the senders, deducting letter postage.

Plants.

Esparto grass (*Stipa tenacissima*), the grass so extensively used in the Mediterranean countries for cordage, baskets, etc., and lately exported in large quantities as a material for paper making. It grows naturally on sandy beaches, within reach of salt water, but will doubtless be found adapted to many saline and alkaline lands now unreclaimed or occupied by the common tule. It should be thoroughly tested in sandy coast lands southward of the bay, and in South California, ten plants (two large and eight small) to each lot.

Black Wattle of Australia (*Acacia decurrens*). A rapid growing, beautiful acacia, with feathery leaves, and valuable for its bark ("Mimosa bark"), which is highly prized as a tanning material. (See report of the College of Agriculture for 1882, page 109.) The Black Wattle is best adapted to sandy lands. It should be understood that the tree is only transplanted successfully when small. Our stock is better and stronger than that offered two years ago. A quantity of seed still remains undistributed, and can be had on application. Lots of ten plants.

Pistachio nut (*Pistacia vera*). A number of seedlings of this tree, which is as yet comparatively rare in California, though manifestly adapted to a large part of the State, have been grown from seed imported last year. The Pistachio is naturally a slow grower, and will not become more than a small tree at best. Although small, these trees should be set out wherever they are to remain, as they are difficult to transplant when once rooted, owing to the nature of the deep-going roots. As the plants are small they, of course, need tender handling at first. Lots of five plants.

The Carob tree (*Ceratonia Siliqua*), the true "Algaroba" or St. John's bread of the Mediterranean region, has been heretofore recommended for cultivation in the southern part of the State, on dry and otherwise unavailable hillsides as well as in richer and moister lands, for the production of an excellent milk-producing feed. (See report College of Agriculture of 1884, page 100.) The Carob is about as hardy as the orange, but owing to its drought-resisting qualities when once established, is destined to have a much wider range than that tree. Four plants to each, it being necessary to make sure of having both staminate and pistillate trees together.

European or English oak (*Quercus robur*). Last season several thousands of acorns of this useful timber tree were distributed throughout the State. Unlike the American oaks, when transplanted to the climate of California this tree proves to be a rapid grower, unexpectedly resistant of drought, and promises well as the hardwood timber tree of the

future on the Pacific Coast. It is not choice as to soil and location, and would probably do well both on the mountains and in the plains, where the latter are not too dry. Its success should be extensively tested. Six plants to each.

The *New Zealand flax*, so useful to gardeners and vineyardists for the purpose of tying with the ribbons into which the leaves readily split, and which are exceedingly strong, is again offered for distribution. Reports received from the interior of the State point strongly to the conclusion that the plant is unadapted to the hot interior valleys. From all coast regions the reports are good. Although fond of moisture, it is not a marsh plant and will not succeed in a swamp. Six plants to the lot.

The *Ramie*, the so called Chinese grass, of which the cheap preparation for textile purposes by machinery seems now to be in the way of accomplishment, should be more extensively tested. It succeeds exceedingly well at Berkeley, in heavy adobe, and is known to do well on sandy soils. Late reports prove that the plant is well adapted to the greater part of the State, and that it will succeed in a great variety of soils. Six plants to each.

Australian salt bush (*Atriplex nummularia*), a forage plant adapted to salty and alkali soils (see report for 1882, p. 117), belonging to the Lamb's quarter group of plants, is much liked by cows. We have very conflicting reports as to the usefulness of the bush as a fodder, some praising it highly, others not being satisfied with it. Ten plants to each lot.

Caper plant (*Capparis spinosa*, variety *inermis*). The thornless caper seems to succeed well, even at Berkeley, and would doubtless do much better in warm locations where it would not be cut down by frosts. It bears abundantly, and, as a small industry, to be carried on by children, its cultivation would doubtless pay.

Coffee tree (*Coffea arabica*). To experiment with this tender plant will be useless for any but those situated in the most favored localities, as regards exemption from frost. It will only succeed where the frosts are very slight and of short duration—such as the tomato will endure. We think that such localities may be found in the extreme southern counties. The plants were grown from seed imported from one of the mountain plantations in Guatemala. Five plants to each.

Resistant stocks. A limited number of rooted cuttings of *Vitis Arizonica* are offered for trial as resistant stocks in vineyards infested by the phylloxera. Five plants to each.

Cuttings and Scions.

Cuttings of the *Huasco grape*, from Chili, producing the splendid raisins exported from that country. This grape has ripened in different parts of the State on grafts distributed by this institution. It seems in many respects to be identical with the Muscat of Alexandria, but has fewer seeds and a more robust habit of growth.

Scions of the following named varieties may be had on application, as stated above:

Pears.

Our collection of pears is very good, and the quality of many of our winter fruits, especially, excellent; but the presence of the summer fogs has the tendency to give them a russet surface—a tendency being more and more pronounced every year. Hence they have never attracted a great deal of attention at the various fairs where they have been shown. A different climate will change this the first season. As regards the pear fungus (or scab), so severe last season, it has this year done but little damage here, as in other localities; but we record the remarkable case of several varieties exempt last year, but badly infested this season. It shows, therefore, that none are entirely to be trusted.

We give the time of ripening of this locality, which, compared with the greater part of the State, is very late. Those starred (*) have proved exempt, or nearly so, every year since fruiting here:

Anne Ogereau; very handsome pear; beginning of August.

Ott; middle of August, before Seckel; small, but delicious.

Duchesse Precoce; above medium; a steady bearer, fair quality; end of July.

*Doyenne Robin; medium to large; beginning of September; good bearer; fair quality; excellent keeper.

Dr. Reeder; tested here for the first time this season; small, but of the highest quality; end of September, beginning of October, after Seckel.

*Paradise d'Autumne; September and October; medium size; very good.

*Marie Louise d'Uccles; end of September; small grower, but a large and constant bearer; fruit large, good quality.

*Sheldon; large; end of September; good.

*Conseiller de la Cour; large; regular bearer; good; middle of October.

*Jalousie Fontenay Vendee; medium; good bearer; resembles in taste Beurre gris, of Europe.

*Pitmastons Duchesse d'Angouleme; a pear entirely different from the ordinary Duchesse; is later; large to very large; so far a shy bearer; good.

*Baronne de Mello; medium; regular bearer; November; good.

Augustus Dana; large; November; very good; so far a shy bearer.

*Beurre gris d'hiver nouveau (new gray winter pear); a variety, we are told, which was formerly cultivated considerably in Santa Clara, but now not met with; large to very large; tree a good regular bearer; quality very good; November and December.

*Md. Lariol de Barny; large, good bearer; good (resembles Emil d'Heyst).
*Jaminette; above medium size; November and December; excellent keeper; good; (extremely sweet).
Fondante de Noel; above medium; very handsome; December; good.
*Jones Seedling; small; a good steady bearer; October; good.
Duhamel de Monceau; December; above medium; very good; tree a poor grower.

Plums.

Black Morocco; small blue plum; the earliest we have.
Ontario; the best early plum we have; green; above medium; quality fair.
Wangenheim prune; resembles the true German prune closely, but bears steadily here, while the latter does not.

Apricots.

Blenheim, Alberge de Montagamet, Purple, Kaisha, Canino Grosso, De Coulorge, and "Beauge," improperly so named (a handsome, highly colored, oval clingstone of medium size and good quality), are among the less known varieties worthy of trial in the State, and of which scions can be sent.
Address applications to E. W. HILGARD.

UNIVERSITY OF CALIFORNIA, BERKELEY, CAL., December 29, 1885.

SUMMARIES OF THE DISTRIBUTIONS OF 1884-5 AND 1885-6.

Records are carefully kept of the applications for plants and seeds in proper books, and all correspondence is preserved for reference. As money was called for to pay for expenses of packing and transmission, it is proper to introduce full statements concerning the moneys received and expended, and to add thereto other facts which will show the numerical and geographical extent of the distribution, and incidentally the interest manifested by agriculturists in the progress of the work.

Seed Distribution, 1884-5, as per Bulletin No. 22.

KINDS OF SEED.	No. Packages.	No. Pounds.
Barleys	122	122
Ryes	17	17
Wheats	41	41
Oats	26	26
Grasses and forage plants	259	130
Trees (black wattle)	117	7
Pyrethrums (insect powder)	148	5
Sundry seeds	27	6
Totals	757	354

These seeds were distributed to two hundred and ninety-eight applicants.

FINANCIAL STATEMENT.

Expenditures.

Total receipts in coin, postage stamps, etc.	$81 36
Mailing packages	$53 29
Mailing letters	1 82
Cash returned*	11 32
Two thousand paper tags	3 75
Two hundred two-pound sacks	5 00
Packing paper	70
Expressage	35
Balance transferred to plant distribution account	5 13
Total	$81 36

*Money returned because supply of seed was exhausted.

Distribution of Plants and Scions (per Bulletin No. 29), 1884–5.

Kind of Plant or Cutting.		No. Distributed.
Esparto grass		170
Carob trees		435
English oak		624
New Zealand flax		342
Ramie		78
New Zealand salt bush		222
Sicilian sumac		24
Huasco raisin grape cuttings		603
Sorghum halepense roots (pounds)		43
Total		2,541
Scions (packages):		
Pears	50	
Plums	65	
Apricots	47	
		162
Grand total		2,703

FINANCIAL STATEMENT.

Receipts.

Cash	$24 30
Money orders	48 87
Postal notes	36 67
Postage stamps	52 23
Balance from seed distribution	5 13
Total	$167 20

Expenditures.

Labor	$64 00
Traveling expenses	2 50
Packing material	25 30
Expressage	4 00
Cash returned to applicants*	43 68
Postage on letters and packages	26 82
Total	$167 20

* Money returned because supply of plants ordered was exhausted.

Seed Distribution of 1885–6 (as per Bulletin No. 47, as printed above).

Kinds of Seed.	No. of Packages.	No. of Pounds.
Barleys	184	306
Wheats	76	180
Ryes	104	104
Roots (sorghum halepense)	39	39
Grasses and forage plants	357	57
Trees (black wattle)	153	19
Pyrethrums (insect powder)	301	13
Totals	1,214	718

Of this amount, two hundred and ninety-six pounds were sent by mail and four hundred and twenty-two pounds by express, according to the instructions of applicants.

Lots were sent into every county in California except Alpine and Mono. The seeds were sent to two hundred and forty-seven Post Offices. The total number of those applying for seeds was four hundred and thirty-eight.

FINANCIAL STATEMENT.

Receipts, by letter and otherwise	$110 83
Expenditures.	
Bags, twine, etc.	$10 90
Postage on packages	67 51
Postage on letters	3 12
Cash returned to applicants*	24 70
Prepaid expressage	2 20
Stamps for Bulletin No. 53	43
Stamps on extra packages	47
Balance handed over to plant distribution account	1 50
Total	$110 83

*When applications were made after the supply was exhausted, etc.

Plant and Scion Distribution of 1886, as per Bulletin No. 50.

There were three hundred and fifty-two orders received in accordance with the terms stated in the bulletin, of which three hundred and thirty-three were filled to the extent of the supplies available. The number of separate packages sent was about three hundred and fifty. The proportions of the different plants was about the same as specified in the foregoing account of distribution under Bulletin No. 29, but the aggregate number of plants was much larger.

FINANCIAL STATEMENT.

Receipts.	
Postage stamps	$45 10
Postal orders	63 14
Coin	20 60
Check	75
Total	$129 59
Expenditures.	
Postage on packages	$23 89
Cash returned*	16 79
Express and freight	10 05
Packing material	24 10
Labor and traveling	45 80
Incidentals	3 44
Postage on hand	5 52
Total	$129 59

*Money is returned when supplies of articles desired are exhausted.

EXHIBITS AT STATE AND MECHANICS' INSTITUTE FAIRS.

Properly belonging to an account of the distribution of plants and seeds, is some mention of the effort which has been in progress for several years, to draw public attention to the experimental work of the College of Agriculture, by exhibits at the two leading California fairs—the State Fair at Sacramento, and the Mechanics' Institute Fair in San Francisco. This work, previous to the present year, was excellently done by Mr. W. G. Klee, and the impression produced was seen to be so valuable in disseminating a better general understanding of our aims and efforts, that the exhibits for 1886 were upon a rather more extended scale than on previous years. It is deemed pertinent, therefore, to introduce sketches by competent critics concerning these exhibits:

THE UNIVERSITY EXHIBIT AT THE STATE FAIR.

The display of the College of Agriculture of the University of California is much praised for the interesting character of its materials and the attractive manner in which the dis-

play is made. It is situated in one of the conservatories on the southeast side of the Pavilion, and is visible from the main floor and the galleries from many points of view. About forty-two feet of wall space and table are occupied. There is first a background of a rich red color. Upon the center of this there is a panel upon which the word "University" is wrought out of small sheaves of cereals, the letters being so large as to be easily read from the most distant point in the building. Around the letters there is an ornamental arrangement, also of grain sheaves, which serves as a frame; and still outside of that there are various ornamental designs, also made of small grain sheaves. There are in all two hundred and thirteen varieties of cereals used in the arrangement, each one being clearly labeled, and no duplicate being used. There are ninety-eight varieties of wheat, fifty-five of oats, thirty-eight of barley, fourteen of rye, and eight of spelts. Along the base of this wall design there is a row of bottles, each containing a variety of grain, and all beautifully labeled. This portion of the exhibit gives opportunity for a most comprehensive comparative study of the characteristics of the different varieties of cereals, both in straw and in grain; and it is being well used by the grain growers, who spend much time in viewing and discussing the specimens.

Another feature of the exhibit is the showing of one hundred and four varieties of fruit from the standard orchard of the University. There are fifty-seven varieties of pears and forty-seven varieties of apples, all correctly named and marked with date of picking. This affords quite a clue to the keeping quality of some of the varieties—as, for example, the De Tongres pear, picked August ninth, is still firm and beautifully colored, although six weeks from the tree, and having undergone a freight carriage from Berkeley with the thermometer over a hundred. Some other varieties show similar durability. The correct naming of the fruit shown is made of use by many exhibitors in identifying the fruits they show.

All the grain and fruits shown were grown upon the University grounds, at Berkeley. One of the objects of the experiment is to secure authentic seed for trial by the correspondents of the Experiment Station, who are located in all parts of the State, and all can obtain seed samples of varieties they wish to try by applying to Professor E. W. Hilgard. The standard orchard is open to similar public use. Scions can be obtained at the proper season, either for budding or grafting, and thus many varieties may be obtained, without cost, for trial in all the conditions of soil and climate which exist in the State.

Aside from the agricultural products, the University exhibit is ornamented with photographs showing all the larger buildings of the University, and a table is devoted to the various publications of the institution, which are given to all who are interested. The conservatory in which the display is made is furnished with seats, and the cool air and attractive sights make it quite a place of resort in the Pavilion.—*Pacific Rural Press, September 18, 1886.*

REPORT OF THE JURORS AT THE MECHANICS' INSTITUTE FAIR.

The exhibit made by the College of Agriculture of the University of California deserves special mention. It occupied a prominent position at the eastern entrance to the conservatory; about four hundred square feet of wall space was filled with glass cases, and in front of this was a table thirty feet long, also well filled. The leading feature of the exhibit was the large collection of cereal grains, which has been secured after much effort by the institution, samples having been sought in all grain-growing countries of the world. These grains were shown both in small sheaves and as thrashed grain, in bottles, all samples being clearly labeled with name and native country. There were about two hundred different varieties shown. Upon the experimental farm at Berkeley careful tests have been made to determine the comparative value of the different varieties, and those which promise well are sent out for trial in different parts of the State.

The exhibit included, also, a collection of textile plants, ramie, flax, etc., as grown on the University grounds, with samples of the fiber extracted by different processes. Upon the table were displayed forty named varieties of apples, and sixty-one of pears. These were all grown in the standard orchard, at the University, and being correctly named, proved of much interest to fruit men, who were thus enabled to correct their own local nomenclature, given by them to several varieties, by substituting for these the true and generally accepted botanical names. This is by no means the smallest of the benefits conferred on the community by our State University. The display of fruit was kept in good condition during the whole time the Fair lasted by frequently renewing the samples on the plates. Notice was given that all those desiring scions, for grafting or budding, could have them without charge on application to Professor Hilgard, at Berkeley. Some of the varieties tested at the University have been proved to be of much value, and they are now being introduced into the orchards of the State.

A very interesting feature of the exhibit was the collection of economic plants displayed. They comprised industrial growths from all parts of the world, which are being now distributed each year from the University for trial in the different climates of California. There were branches of cinchonas, or Peruvian bark trees, which grew at Berkeley, but they require full protection in winter. Plants sent to a few parts of the southern counties are thriving and promising well. The caper bush (*Capparis spinosa*) was also shown. It is proving hardy and productive in different parts of the State, and it is quite possible to foment a local industry in pickling capers. There were also fine specimens of bamboos growing in Berkeley. This highly useful Asiatic plant makes an excellent growth in this State, and will, no doubt, serve many useful purposes, especially in parts of the State where timber is scarce. There were four different varieties shown

at the Fair. The true tanner's sumac, grown from seed from Sicily, had a vigorous appearance, and it seems likely that California can supply the United States with this material instead of importing it from the countries bordering on the Mediterranean. Branches of the Chinese tea plant, which is a hardy shrub in many parts, were also shown. The esparto grass (*Stipa tenacissima*), which is so important in the Mediterranean region for basket weaving and other industrial uses, has also proved itself well adapted to California conditions. There was also a fine collection of mulberries, including six varieties, grown with a view of ministering to the growing interest in silk culture.

Among the trees shown and not specified above were the "strawberry tree" (*Arbutus unedo*); the Japanese camphor and cinnamon trees; the carob or "St. John's Bread," so valuable for fodder in Asia Minor and the south of Europe; the laquer tree of Japan; the pistachio nut, etc. All of these are showing adaptation for growth in this State, and promise to be of considerable industrial value.

A prominent feature of the exhibit, also, was the collection of types of wild grapevines from different parts of the world. The investigation of the wild vines has become a matter of much importance, especially pointing to a means of escaping ravages by the phylloxera. The following types, all of which are now growing at Berkeley, were shown:

Vitis æstivalis, Arizonica, Californica, Candicans, Cineria, Cordifolica, Vulpina, Monticola, Nueva Mexicana, Riparia, Romaneti, Rupestris, Katchebrourie and *Opiman* (from Kashmir). There were also specimens of the *Vitis vinifera*, shown for comparison.

There was also an exhibit of the various publications of the College of Agriculture, the reports on agricultural and viticultural experiments, the bulletins, of which about sixty have been issued up to date, giving immediate results of experiments and investigations, which are discussed more fully in the regular reports.—*Official Report Twenty-first Industrial Exhibition of the Mechanics' Institute, San Francisco, 1886.*

DONATIONS OF SEEDS, PLANTS, ETC., DURING THE YEARS 1885 AND 1886.

From John Rock, San José: Collection of olives recently imported from Europe, as follows: *Olea rubra, Pendulina, Macrocarpa, Regalis, Praecot, Salonica, Nigenina, Polymorphum, Atro violancea, Columballa, Beca rupa*, and *Oblonga*. Also two kinds of bamboo.

From C. H. Dwinelle, Berkeley, the following trees and scions: P. Barry pear; Bulgarian prune on Myrobolan stock; Silver prune on Myrobolan; Prince's Yellow Gage on Myrobolan; Myrobolan plums; Smith's Triumph apricot; Marshall's Seedling apple; scions of doubtful St. Catherine plum for testing as to name. Also seed of *Ligustrum japonicum; Ruscus* (*Sp. pegli?*); *Pinus pinea; Laurus nobilis; Ophioponon japonicum.*

From Luther Burbank, Santa Rosa, the following Japanese fruit trees: Chabot plum; long-fruited plum; *Prunus simoni;* Masu plum; Blackman plum; Botan plum; also the Hongkong quince.

From Dr. Gustav Eisen, Fresno: Six White Adriatic fig trees and two melon shrubs.

From G. Tosetti, San Leandro: One Tuscany Yellow Cling peach tree; one Tuscany White ditto.

From A. P. Cleveland Company, Cape Vincent, N. Y.: Seed of Cleveland's "Rural New Yorker pea" and of "Alaska pea;" also "Improved Valentine beans."

From W. Farrer, Cuppacumbalong, New South Wales: Seed of eight leguminous plants from the Punjaub; also two varieties of Indian wheat, claimed to be rust proof.

From A. G. Tillinghast, Padilla, Skagit County, Washington Territory: Six kinds of cabbage seed.

From L. A. Gould, Auburn, Placer County: Seed of tea plant (*Thea bohea*).

From E. T. Bogue, Martinez: Three hundred pear seedlings; one hundred Myrobolan plums.

From Hon. Norman J. Colman, Commissioner of Agriculture, Washington, D. C.: Collection of turnip seed; also seed of yellow lupin, blue lupin, iradella (*ornithopus*), bene plant, alfalfa, alsike or Swedish clover, *vicia villosa*, jaeger bean, puff bean, muskmelon, "todo del ano," from Valencia.

Also, the following wheats: Four-rowed Sheriff, Fulcaster, Genoese, Raub's black prolific; Shine's early prolific cotton, Cherry's long staple cotton; Harris oats.

Also, the following collection of grass seeds: *Agropium divergens, A. glaucum*, and *A. tenernm; Bromus Suksdorfii* and *Bromus sp.(?); Boutelova oligostachya, Deyenxia sp.(?), Eriocoma cuspidata, Agrostis exarata; Elymus triticoides*, and *E. condensatus; Festuca gracillima* and *F. scabrella; Pheleum sp.(?), Poa Nevadensis, Stipa viridula, Sporobolus cryptandrus, Agropius* and *Elymus* mixed; *Koelaria* and *Eatonia* mixed.

From S. Wakeham, Berkeley: Seed of Jersey kale.

From W. Goldi, Auckland, New Zealand: Seed of Japanese grass (undetermined).

From W. Lichtenberg, San Francisco: Seed of Colorado hemp (*Sesfania macrocarpa*).

From Baron Ferdinand Von Mueller, Government Botanist, Melbourne, Australia: Seed of *Eucalyptus amygdalina, E. Gunni, E. pilularis, E. rostrata, E. resinifera*, also *E. macrophylla, Acacia leiophylla, A. pycantha, A sentis*, and *A spectabilis;* collection of five umbellifers from the Himalaya Mountains; *Cinchona succirubra*, also *C. calisaya ledgeriana*, also hybrid cinchona; also seed of the following: *Protea mellefera, Juniperus communis*, and *J.*

Tothergillii, Maximiana carilaea, Pittosporum eugenioides, Heterodendron oleifolium, Elymus arenarius, Simploecos spicata, Daryanthes palmeri, Todea africana, Wallichia densiflora, Prama arenaria, Cryptomeria japonica, Tecoma fulva, Tecoma stans, Polygonum tinctorium, Euchlaena luxurians, Psamma arenaria, Atriplex haliminoides and *A. numularium, Tristanea conferta, Pentzia vergata, Ficus macrophylla.*

From H. P. Gregory, San Francisco: *Clerodendron fallax, Poinceana pulcherrima, Cassia nodosa.*

From Mrs. P. Reynolds, Healdsburg: Four varieties *hippeastrum; Gloriosa superba.*

From E. Somers, Berkeley: Seed of *Pieraena excelsa, Croton tiglium,* oil seed from West Africa (undetermined), *Archangelica officinalis, Rheum undulatum.*

From the Director of the Department of Agriculture and Commerce, Cawnpore, India: A collection of seeds of East Indian trees. A letter from the Assistant Director gives valuable information concerning the trees, and we extract the following:

"The 'Dhak' (*Butea frondosa*) is abundant all over the northwest portion of India, growing wild, on the open uncultivated plains. It is used for bottoming well cylinders, but is excellent fuel and is largely used for this purpose. It is almost the only tree, except *Babul* (*Acacia Arabica*), that will do at all well on waste land, even in the soil which is slightly impregnated with alkaline substances. In the plains it seldom is more than a stunted shrub; but at the foot of the lowest range of hills it attains the dignity of a tree, and the effect produced in the month of March by its clusters of large orange-red flowers is very striking, and has often been compared to that of a jungle fire. A yellow dye is obtained from the flowers of this tree, which has some commercial value. The seed should be sown while in pods soon after its arrival in California. It does not bear transplanting.

"The 'Shisham' (*Dulbergia sissu*) is a large tree with light-green delicate foliage and small yellowish white flowers. It is indigenous in the sub-Himalayan forests. A light soil is essential to its success, and it flourishes luxuriantly on low-lying, sandy alluvial tracts. The heart-wood is dark brown and is much used in cabinet making, and perhaps the only best wood next to mahogany for the purpose in India; young leaves and twigs used as cattle fodder and as alterative medicine. Propagation is effected either by seed sown in March, or very easily by cuttings, which latter should be slips one foot long. Put down in February, seedlings may be transplanted in January, February, or in the rains. The distance between the trees planted out should be thirty feet. The seeds sent should not be separated from the pods, but sown whole immediately after arrival; may be grown in nursery and transplanted.

"The Indian tamarind (*Tamarindus Indicus*), is a large tree often over eighty feet, cultivated throughout India with subdivided (pinnate) leaves, and yellowish flowers in loose clusters. The trunk is short and thick, crown magnificently broad and high. The pods contain an acid pulp which is much preserved, and is an invaluable antidote for scurvy. It is extremely slow growing. The seed is sown in nurseries in April. The seedlings must be protected from frost during the first cold weather, and transplanted in February, or during the rains. The trees should be planted forty feet apart on the roadside. The wood is of no value but for fuel.

"The 'Nimi' (*Melia Indica*) is a large tree common throughout India, and will grow on any soil. The bark is gray, with numerous dark longitudinal and oblique wrinkled furrows; leaves subdivided, unequal sided; flowers small, white, with strong, rather offensive smell of honey. The fruit contains an acrid, bitter oil, which is used medicinally; is also used for burning. The coke and oil are a good remedy for insect pests and diseases attacking field and garden crops, and animal wounds. The timber is good for building purposes. The natives believe in hundreds of medicinal properties, which they say the bark, wood, and leaves of the tree have. The seed is sown in nurseries or in *situ;* four or five being sown, and the strongest seedling being allowed to remain. The seedlings are planted out in the cold weather, or in the rains, and should be planted forty inches apart.

"The 'Kikar' (*Acacia Arabica*) is also called babul; under favorable circumstances, a large tree covered with long, straight, whitish colored spines, the points of which are very sharp, and often of a brown color. The leaves once subdivided (pinnate); flowers yellow, in globose heads. The bark and pod are much used in tanning. The leaves and pods make excellent fodder. The gum has commercial value. The tree is common in Upper India, east and south of the regions of extreme frost, which it is unable to stand; will do well on heavy soil, and thrives even on gravelly land. The wood is used in making handles of tools and heavy wagons. The seed is sown at the commencement of rains in nurseries, or better in permanent places; seed patches two feet square being prepared along the roadside at intervals of ten feet. When the plants grow, thin out in the second, third, and successive years, taking out the weakest plants until, ultimately, in the seventh and eighth year, only one tree is left to each patch. The distance between the trees should be twenty feet, ultimately forty feet, by removal of alternate trees.

"Other plants received are 'Renrja' (*Acacia uncophhea*) and 'Chamikar' (*Prosopis spicyon*). These two trees may be treated as the 'Kikar,' and are very hardy; they grow on any soil, but very slowly. They must not be transplanted."

From Dearborn & Co., Oakland: Two Keiffer pear trees.

From Dr. J. H. Watkins, Palmetto, Georgia: Seed of Kaffir corn.

From W. T. Garratt, San Francisco: Seed of American pawpaw.

From John Irwin: Cuttings of European basket willow.

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